EDUCATIONAL HANDWORK
OR
MANUAL TRAINING

DIRECTOR OF INDUSTRIES
Bengal

EDUCATIONAL HANDWORK

OR

MANUAL TRAINING

BY

ALFRED H. JENKINS

FIRST CLASS DIPLOMA IN MANUAL TRAINING OF CITY AND GUILDS OF LONDON
INSTITUTE, DIPLOMA OF LEIPZIG, DIPLOMA OF SLOJD SCHOOL, NÄÄS
(WITH SPECIAL ABRAHAMSEN MEDAL)
SUPERINTENDENT AND PRINCIPAL INSTRUCTOR IN MANUAL OCCUPATIONS
TO THE ST. ANDREWS PROVINCIAL COMMITTEE FOR THE
TRAINING OF TEACHERS; LATE DIRECTOR OF MANUAL
INSTRUCTION TO DUNDEE SCHOOL BOARD

DIRECTOR OF INDUSTRIES
Bengal

LONDON: W. B. CLIVE
University Tutorial Press Ld.
HIGH ST., NEW OXFORD ST., W.C.
1915

PREFACE.

TEACHERS who are interested in Educational Handwork have hitherto been compelled to collect their information from various sources, and have long felt the need of a good book containing an adequate account of the different branches of the subject. The object of this book is to give in one volume a course of instruction dealing with all the processes and forms of Handwork commonly practised in schools.

To enter fully into details in all the various branches of the subject would require a volume of considerable size and proportionately considerable cost. The author has therefore, in order to economise space, adopted the plan of treating most fully those forms which are most commonly adopted. Thus, for instance, it will be found that Paper and Cardboard modelling and Woodwork have been dealt with very fully.

In the Woodwork section brief notes of lessons on Tools and Timber are given; they deal, however, only with the matter, for the Teacher will have no difficulty in supplying the method. The Bench notes show the order of procedure and should be supplemented by individual instruction: they do not attempt to give full instruction in the use of the tools. Questions of equipment are throughout fully treated, and suggestions are given for economical expenditure on tools and materials.

The author does not pretend that all the models are new and original. Many of them are old and well-known, but are included because of their suitability.

The various courses here given are intended as suggestions, and should not be taken *en bloc* as suitable for every type of school; each school should have its own scheme of Handwork, with models suited to the locality.

The author's object has been to assist the teacher in arriving at a satisfactory course embodying exercises in a variety of materials, and he hopes that this aim has been attained. Special attention has been given to method and to the difficulties that commonly occur in class management.

The following table will show at what age the different occupations are most suitable: —

	7-8 yrs.	8-9 yrs.	9-10 yrs.	10-11 yrs.	11-12 yrs.	12-13 yrs.	13-14 yrs.
Plastic Work .	×	×	×			×	×
Raffia Work . .	×	×	×				
Basketry .			×	×	×		
Paper Work . . .	×	×					
Cardboard Modelling...			×	×	×	×	×
Light Woodwork				×	×	×	×
Heavy Woodwork .						×	×
Metal Work						×	×

CONTENTS.

CHAPTER | | PAGE
I. INTRODUCTION . . . 1
II. FORMS OF EDUCATIONAL HANDWORK 6
III. PLASTIC WORK . 11
IV. RAFFIA WORK 19
V. BASKET WORK . 32
VI. PAPER WORK AND CARDBOARD MODELLING 43
VII. WOODWORK . 100
VIII. LIGHT WOODWORK . 181
IX. METAL WORK . 191
INDEX 223

DIRECTOR OF [illegible] STRIES
Bengal

The following list of contractions used in the book is given here in alphabetical order for convenience of reference :—

(C.M.)	Cardboard Modelling
(C.R.)	Copper Repoussé.
(F.)	Forging.
(H.I.)	Heavy Iron.
(H.W.)	Heavy Woodwork.
(L.W.)	Light Woodwork.
(P.W.)	Paper Work.
(R.W.)	Raffia Work.
(S.M.)	Sheet Metal.
(S.I.)	Strip Iron.
(T.P.)	Tin Plate.
(W.W.)	Wire Work.

CHAPTER I.

INTRODUCTION.

Educational Handwork.—This subject has been known under a variety of names. "Manual Training," "Manual Instruction," "Hand and Eye Training," "Handicraft," "Sloyd," "Learning by Doing" have all stood for that branch of education which seeks to develop and instruct a child by the employment of his hands in the manipulation of materials in a variety of operations. All the terms suggest that the main idea is work with the hands. In working with the hands the eye too must be called into use, and the mind also in directing both hand and eye. This "hand education" is a type of education opposed to the old form of "bookish" education.

The inclusion of Handwork in the Curriculum.—There is no need to set forth arguments to justify its inclusion. The question arises "Why has it not always been part of our educational programme?" To understand this it is necessary to go back to the period previous to the Industrial Revolution. In those days, when most of the arts and crafts were practised in the home, the education of the child was as much the work of the home as of the school. The more "bookish" side of the education—reading, writing, and arithmetic—was taught in the school, whilst at home, the child, who was constantly in touch with the work of its parents, watching them and assisting them, was all the time gaining dexterity and a real knowledge of the principles underlying the work.

After the Industrial Revolution the introduction of machinery and steam power saw the work transferred from the home to the factory, and the child lost his opportunity of home hand training. The book learning still continued as the work of the school, and thus we had, for a long period, a lop-sided education which neglected a very important side of the child's preparation for the battle of life. Manual training in the form of needlework, cookery, and laundry work for girls, and in woodwork for boys, was then introduced, especially in schools for the poorer classes. This was introduced purely from the utilitarian point of view and for a time continued as such, till educationists began to find in it a new educational power. Manual training came to be regarded in the light of a new method. In it they saw the direct application of the principles of Rousseau, Pestalozzi, and Froebel, that the best method of learning was by doing, and that the teacher should guide and lead the child to observe, to compare, and to note for himself by using his natural activity and interest in things around him.

Manual Training and Technical Training.—Confusion and misunderstanding often arise over these two terms. They are not synonymous, but each has a distinct and separate meaning. Technical training is generally understood to mean instruction and development of dexterity for a particular branch of trade or industry. Manual Training or Educational Handwork does not prepare the child for any particular trade, but seeks to develop a skill of hand and eye, and an attitude of mind which will serve as a foundation for special technical training at a later stage.

Psychological and Sociological Aspect.—Psychologists point out that most children between the ages of 7 and 14 years have an aptitude for acquiring dexterity which diminishes with succeeding years. It is necessary therefore, if we wish to achieve a high state of efficiency, to begin practical training at an earlier stage than is done in the technical schools. There is a movement in this direction in the trade schools, vocational schools, and preparatory technical schools, but the training of general manual dexterity should commence even at an earlier stage, namely, in the classes of the primary school.

Apart from its utilitarian value, psychologists show that educational Handwork acts as an intellectual stimulus and assists in the development of certain brain centres. This is particularly evident in the case of mentally defective children and in children whose mental development in its earlier stages has been some-what retarded by sickness or by other causes. In such cases Handwork often gives them an opportunity for performing work in which they gain a certain amount of success and in which they are able to feel satisfaction in something achieved. This success gives them self-confidence, which reacts to a great extent on their other studies.

Its value is found also in the case of children of an excitable and hasty disposition. The work impresses upon them the necessity of slow and careful procedure and is found to have a steadying influence on such a type. In Industrial Schools the benefit of some form of Handwork is fully recognised as a means of directing misplaced energy along lines calculated to develop both mind and character.

The child who has learned to use his hands in some form of Handwork will in all probability continue with some form of handicraft when his school days are finished, and so will find a rational use for his leisure hours in after life. Educational Handwork, too, brings the work of the school into closer touch with life outside the class-room, and the child's attitude towards manual labour will be one of respect and appreciation. The result will be that the arts and crafts generally will be uplifted and the whole attitude towards manual labour altered.

Aims of Educational Handwork.—Briefly stated, the aims of Educational Handwork are:—

1. To develop manual dexterity.
2. To train the power of observation in certain directions.
3. To develop physical strength (in the higher forms).
4. To afford scope for self-expression by means of the motor activities.
5. To create pleasure in bodily labour, and to keep the child in touch with its environment.
6. To cultivate habits of independence, order, accuracy, attention, and industry.

Continuity.—The principle that manual occupation and bodily activity should form a large part of the early education of young children is well carried out in the modern infant school, but it often ends there. The work of the junior and senior classes is in many cases of an entirely different nature, the time being devoted mainly to intellectual work. This sudden transition from the bodily activity of the infant room to the purely mental work of the junior classes is not following a natural development. The change should come more gradually; and if the Handwork is to be resumed in the upper classes it should be continuous in some form or other throughout the whole period of school life.

The main difficulties in the way are the large classes of the Junior and Senior Divisions, the difficulty in finding a suitable occupation, and the inability of the teacher (through lack of technical knowledge) to teach the subject. The difficulty of the large class can be overcome to a certain extent by organisation and by suitable arrangement of the time-table. Opportunities for studying various subjects of Handwork are now plentiful, and in the Training Colleges courses of Handwork are offered as part of the Scheme of Studies. With regard to the choice of an occupation, it is advisable that no one type of Handwork should be adhered to. Various media should be employed and the child should be trained in a variety of operations.

Correlation.—The teacher of Handwork, if he teaches his subject from the right point of view, and does not regard it as an extra subject, will find in it ample opportunities for supplementing and illustrating in a practical way the ordinary work of the class. In Drawing, Arithmetic and Geometry, Mechanics, Physics, Nature Study, Geography, History and Literature, and in Recreation, the teacher will find much that can be advantageously used in Handwork. At the same time some of the occupations, *e.g.* woodwork, have a sequence of tool operations with which too much liberty should not be taken for the sake of correlation, or the educational value of the Handwork suffers in consequence.

The Teacher.—If proper correlation is to be obtained it will be necessary that the class teacher should teach the Handwork. In the infant and lower division this is generally the case, but in the higher classes the work is generally in the hands of specialists. It will be necessary that the specialist should not only have a true conception of the educational side of his subject, but also have an intimate knowledge of the work being undertaken in the other subjects.

The most widely adopted form of Handwork for boys in the upper classes is woodwork, and in many cases the teacher has been a joiner. It is evident that unless such a man has a good education and is an educationist also, the real value of the subject is lost. His point of view will be that of the joiner—the technical point of view rather than the educational one. The cost of equipment has brought the "centre," which is not a very desirable arrangement, as it tends to set manual training as a subject apart from the ordinary work of the school. Where possible a room in each school should be set apart for the work, and each class teacher should either teach, or assist in teaching, the Handwork of his own pupils.

DIRECTOR OF INDUSTRIES.
Bengal

CHAPTER II.

FORMS OF EDUCATIONAL HANDWORK.

Various Media Employed.—Clay, paper, cardboard, string, raffia, cane, wood, and metal are all used as media in the various forms of Educational Handwork. Formerly "Educational Handwork" and "Woodwork" were practically synonymous terms, but the attempt in recent years to "bridge the gap" has brought about the introduction of a variety of occupations. Each medium has its limitations, and is more suitable for certain types of work than for others. Clay, for example, is much more suitable for expressing form and for the training in aesthetic appreciation, than any of the other media. Work which requires accuracy of measurement and which seeks to provide for the exercise of the constructive ability of the child is best executed in cardboard, wood, or metal.

A well-arranged scheme of work should introduce a variety of media, so that the advantage of each may be obtained and in order that both the artistic and the mechanical sides of the child's nature may be properly developed. A variety of media also lends added interest to the work, whereas a course of work confined to one medium might prove monotonous.

Selection of Occupation.—In selecting a suitable occupation the teacher will have to keep in mind the following points:—

(*a*) The inclination and ability of both teacher and class.
(*b*) The locality in which the school stands.
(*c*) The age of the children and the size of the class.
(*d*) The medium employed.
(*e*) The equipment and accommodation in the school.

(*a*) *Inclination and Ability of the Teacher.*—Almost any type of Handwork in the hands of a capable and enthusiastic teacher will have good results, but both teacher and children must be in sympathy with the work. The ordinary class teacher, as a rule, is not specially trained in this branch of education, so that in many cases he selects an occupation that he feels he can teach without a great deal of preparation. Paper and cardboard modelling, which is practically applied geometry, has become a very popular occupation on this account Some teachers are not strong on the artistic side, so that subjects like brushwork and clay modelling would not appeal to them.

(*b*) *The Locality.*—The character of the work followed will, to a great extent, be influenced by the surrounding district. In a rural district weaving applied to basket-making, rural carpentry, and metal-work would appeal to the children. In seaside districts modelling of shells and fish in clay, string-work and the weaving of nets, and woodwork applied to the various needs of the fisherman could all be followed with advantage. In industrial centres the more accurate work of cardboard modelling and specially selected woodwork exercises would make an excellent training for pupils, who would ultimately join the building trades or become mechanics. In textile districts brushwork, with a view to its ultimate application to design, and weaving in coloured threads and raffia work would be specially suitable.

(*c*) *The Age of the Children ; Size of the Class.*—In the first case the occupation will need to be one which the child is physically capable of following. In young children the imitative tendency is strong, so that clay modelling, paper folding, and raffia work would lend themselves to Handwork for the lower classes. Accuracy of measurement and constructive ability belong to a later period, so that work of this kind should not be taken up till later on in the scheme.

The size of the class influences the selection of a suitable occupation. Certain types of Handwork require more individual attention than others. With a large class the teacher will need to select a type of work which is self-testing (*e.g.* cardboard modelling) as opposed to brushwork or clay modelling, which require the teacher's criticism before the child knows whether his result is satisfactory or not.

(*d*) *Medium Employed.*—A suitable medium should be one that is easily manipulated by the child, *e.g.* the paper for paper tearing should be of suitable texture, and in cardboard modelling the cardboard should not be too heavy or too hard for the child to cut through with a reasonable amount of effort. In woodwork the wood selected for early exercises should be easily worked, and the harder woods should not be introduced till the pupil has gained strength and skill in the use of the tools.

The material employed should be easily distributed, easily stored, easily kept in working condition, and should not be so expensive as to interfere with the amount of work done. As far as possible the material selected should be one which the child can procure for himself, and thus continue the handwork at home.

(*e*) *Equipment and Accommodation.*—Most of the occupations for the lower and middle classes can be carried out in the ordinary school desk, and cost little for tools and material. For woodwork and metal-work special benches and tools are required. In large towns the tendency has been to make "centres," thus economising in tool equipment. The centre is unsatisfactory from an educational standpoint, and where possible a workshop should be attached to each school—no matter how small. A grand array of tools is not essential. Generally speaking, the simpler the tools and equipment, the more is the individual thrown on his own resources, and the more real hand and eye-training he obtains. The woodwork benches by a slight modification can be made suitable for many studies; and the workshop might easily be used as the nature study museum, the physics and mechanics laboratory, the needlework and laundry-room, and general Handwork room of the school.

Notes on the Various Forms of Educational Handwork.

Plastic Work.—Very widely used—suitable for all stages, particularly lower stages—inexpensive—little apparatus required—may be carried on in the ordinary school desks—clay needs careful storage—"Plasticine," excellent substitute for clay, but rather expensive—teaches accuracy of form, but not very good for accuracy of measurement—can be correlated with many school subjects.

Raffia and String Work.—For lower classes after infant room—

material cheap and easily stored—by dyeing, artistic decorative effects may be obtained—models of utility may be constructed—after a time it becomes rather monotonous as it involves too much repetition of the same processes.

Cane Weaving.—Suitable for children of the middle classes—material not very expensive—easily stored—work may be performed in ordinary school desk—operations become more or less mechanical, and models usually take a long time to complete—cane must be worked in damp condition—this not very good for physically defective children.

Paper Folding.—Very widely adopted—suitable for children of the infant and lower classes—material cheap—easily stored—worked in ordinary desks—work may be repeated at home—teaches accuracy of form and measurement—is a good introduction to cardboard modelling—objects of utility may be made.

Cardboard Work.—May be taught throughout the school—great variety of work—variety of material, colour, and shapes obtained—models do not take too long to finish—may be carried on in the ordinary desks with little apparatus and inexpensive material—appreciation of form and colour may be cultivated and great accuracy can be obtained—affords an excellent preparation for woodwork and metal-work—may be correlated with other school subjects, particularly geometry and arithmetic.

Light Woodwork.—Practised in different forms—strip-work—Sloyd knife-work—natural woodwork—usually taken as an introduction to heavy woodwork and as an alternative to advanced cardboard modelling—practised on ordinary school desk with a few not very expensive tools—a number of useful and artistic objects may be made—may be used in conjunction with cardboard modelling to great advantage.

Fretwork, marquetry work, chip-carving, ordinary relief-carving are not very suitable forms of Handwork, but may be used occasionally in woodwork in correlation with drawing. Many of the models present spaces which can be decorated with suitable designs, which should be prepared by the pupils in the art room. Work in these branches usually takes a long time to complete, and for the small variety of manipulation employed, is not to be recommended for Educational Handwork.

Woodwork is very widely employed; wood forms an excellent medium to work in. Work only suitable for pupils over 11 years, as it requires a fair amount of physical strength. Special equipment and special ability on part of teacher required. The work offers a variety of manipulative exercises, and is good both from the formative and from the utilitarian point of view. Classes should not exceed 20 pupils, and a period of at least 1½ hours should be given to each lesson.

Metal-work.—Usually practised in the highest classes, following a course of woodwork, but may be suitably arranged to take the place of woodwork. Work is heavier than woodwork and requires more strength, hence is suitable for boys over 12 years of age. Many different forms—wire-work, sheet metal-work, shaping, forging, repoussé work and machining; the latter hardly suitable for primary school work, belongs more to the trade school or preparatory technical school. Metal-work specially suitable for industrial districts, and may with advantage be arranged in certain forms (*e.g.* wire-work and forging) for rural schools.

A combination of woodwork and metal-work makes a very attractive course, without a great addition to cost of equipment.

CHAPTER III.

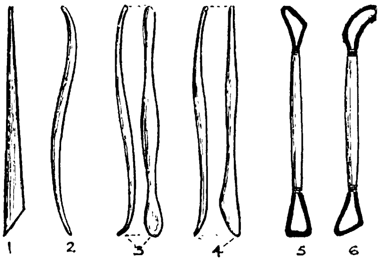
PLASTIC WORK.

Plastic Work.—This is one of the most extensively adopted forms of Educational Handwork, particularly for children in the lower classes. It is inexpensive and calls for little technical skill on the part of the teacher. It is valued more for its disciplinary training than for its utility. No occupation is better calculated to cultivate habits of careful and accurate observation, cleanliness, dexterity of the fingers, and to develop a sense of the æsthetic value of things. The work is very suitable for young children, and the medium is easy to manipulate. The child is offered free scope for his ideas. He creates something tangible, something natural, having three dimensions, not as in the case of drawing, for example, where the result is merely a representation of the object which is more or less conventional. He is not confined to flat surfaces as in many of the other occupations, so that there is a good opportunity of developing artistic taste in form.

Materials.—Whether clay or plasticine is the better medium is a matter of opinion. Clay requires attention to keep it in condition, whilst plasticine is always ready for use, and may be had in a variety of colours. Clay, however, is much cheaper, and consequently a larger quantity can be supplied to each pupil than will permit in the case of plasticine. This allows a wider choice of models, and does not confine the work to small objects and to flat shapes. The clay used is the ordinary grey clay of the pipemaker, and costs from five to eight shillings a hundredweight. Terra-cotta clay is sometimes used because it is cheaper, but it is coarser to work, and shrinks more than grey clay.

One hundredweight will be found sufficient for a class of thirty children to begin work.

Tools.—Modelling should be done mostly with the fingers, but in inaccessible places and for special purposes modelling tools may be used. These are either of wire or of boxwood about 7 in. long. They are made in a variety of shapes and can be purchased quite cheaply from most artists' colourmen.



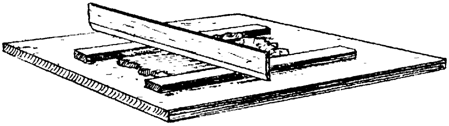
1-4 WOODEN MODELLING TOOLS
5, 6 WIRE MODELLING TOOLS

Above (Fig. 1-6) are shown a few of the most useful shapes. The wire tools are used chiefly for cutting out. Small sponges are also required for moistening the fingers when modelling.

If possible, a room should be set apart for clay modelling, as in the ordinary class-room the clay is apt to soil the desks and the floor. A special room is also more convenient in the matter of storage of materials and of work. If the work is conducted in the ordinary class-room, a piece of American cloth may be used to protect the desk.

Modelling Boards.—For modelling with clay the ordinary school slate will serve admirably, but with plasticine the greasy nature of the medium tends to spoil the slate. For plasticine a piece of stout leather board, about 12 in. by 10 in., treated with a couple of coats of linseed oil, will be found quite suitable. A piece of three-ply wood will serve equally well.

Slab Board (Fig. 7).—In the early stages most of the exercises are modelled in the hand, but in the later stages the exercises are modelled on a slab of clay or of plasticine. The preparation of the slab without the aid of a slab board forms a good exercise in itself, but to save time in an exercise where the slab is of minor importance, the slab board may be called into use. Two strips of wood, about 9 in. long, 1 in. wide, and thickness corresponding to the depth of slab required, are fastened on a board either by wire nails driven through, or by pieces of clay pressed at the sides of them. The strips are parallel, and the distance between them regulates the width of the slab. The space between the strips is filled in with rolls of clay which are smoothed down with the thumb. The slab is finally levelled by drawing a sharp-edged scraper of wood (a ruler will serve the purpose) across it, the ends of the scraper resting on the gauge slips. The scraper should be drawn obliquely across the slab, so as to slice the clay, otherwise there is a tendency to lift it.



SLAB BOARD

Fig. 7.

Storage of Clay and Work.—The main difficulty with clay is to keep it in condition. To test it, take a small portion, roll it into a ball and press it between the thumb and finger. If it is in good condition the thumb and finger will meet easily, and when opened will come away clean without any portion of the clay sticking to them.

It should be stored in a zinc-lined box about 3 ft. by 2 ft. and 1½ ft. deep, with a lid. A small galvanized dust bin or a large tin bath, covered with a piece of moist flannel, will also serve the purpose. To keep the clay in condition it is necessary to turn it occasionally and to beat it up well to get it to a uniform consistency. If it is allowed to dry it becomes hard and brittle. Should this happen, break it down to small pieces and soak it for a couple of hours in a pail of water, drain off the water and knead it up again with a mallet or a thick piece of wood. Leave it for a day exposed to the air and work it up again the next day, when it should be ready for use.

If it is too wet it is sticky and dirty. To dry it, work in amongst it a little dry clay powder, or leave it exposed to the air for a day or two, kneading it at intervals.

The clay must be in proper condition, or it is useless to try modelling in class. Plasticine has none of these disadvantages, but it renders the hand greasy and necessitates the use of hot water and plenty of soap before any paper work can be undertaken.

In the early stages most of the exercises will be completed in one lesson, and the material returned to the bin. Some of the best exercises may be kept for exhibition, but in time as the clay dries it becomes extremely brittle unless it is baked.

In the later stages the work in hand may extend over two or three weeks, in which case the model must be carefully stored to keep the clay in condition for further work. The model should be stored in a cool place and should be covered over with a piece of flannel which has been dipped in clean water and wrung out lightly. A couple of minutes' attention morning and evening will suffice to keep it soft and plastic.

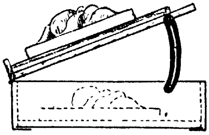


Fig. 8.—Clay-modelling Box.

For the advanced classes, a box as shown in Fig. 8 is very convenient. It is fitted with a hinged lid which can be tilted and held in position by clamps at the sides. The bottom of the box is close fitting, but can be removed, and is used as a modelling board. When the work is finished it can be replaced in the box and a damp cloth placed over it. Boxes can then be piled one on top of the other without fear of damaging the work.

General Method.—As far as possible the work should be done with the fingers. Modelling is a building up process, quite opposed to carving, which is a cutting down process. The introduction of tools at an early stage tends towards carving, which in modelling is regarded as bad technique. The building up should be begun with fairly large pieces first, working towards correct proportion of the various parts, and, as the work progresses, smaller pieces rolled into balls should be applied and pressed into the required form.

Smoothness of finish is not essential. There is rather a tendency among children to smooth up their work, and in so doing to spoil its character. A model should be supplied to work from, and the children should be allowed freedom in the expression of their observations, the teacher merely suggesting methods of manipulation. Too much help on the part of the teacher weakens the child's observation and tends to check individuality.

Suitable Models.- In the lower classes a hard and fast course of exercises is not advisable. The subject can be used to great advantage in the cultivation of imaginative expression. The child should be left free to experiment with clay and to attempt to model forms with which he is more or less familiar. This strengthens the memory of form and encourages observation as he will afterwards more carefully study the object to see what he has omitted and wherein he has erred. Nature objects used by the children in the schoolroom, nursery rhymes and scenes acted by the children will all furnish suitable models. Groups of objects all based round a central idea, *e.g.* the seaside, the garden, a picnic, will form interesting studies. With the older children more care will be taken with detail and with accuracy of form and proportion.

As far as possible a model should be provided for each child, or at least one between two, so that each pupil can examine it at close quarters. Suitable objects should be selected and arranged according to their difficulty.

Fruits of a spherical shape might be taken first, such as the orange, cherry, apple, onion, and turnip; ovoid forms might follow, *e.g.* lemon, pear, acorn; then elongated shapes, *e.g.* banana, bean pod, radish, carrot, shells, common objects such as bradawl, screw driver, clothes peg.

Leaf forms should be modelled on a slab, the top surface only being modelled and the thickness of the leaf being shown by the angle made between the slab and the surface of the leaf.

For the more advanced classes there are innumerable objects for modelling; Nature study offers quite a number. Flowers, twigs, seeds, insect forms enlarged, fish, crustaceans, can all serve as suitable objects.

Memory modelling, aided by notes and sketches of forms seen in the museum, is a useful exercise.

Objects connected with the history lessons can also be modelled, *e.g.* weapons, utensils, head-gear, foot-coverings, types of dwellings—model to illustrate an action on the battlefield.

Modelling can be used to assist the study of physical geography. Contour models are best worked as collective models, several pupils working on the same model. Sheets of clay of even thickness (*e.g.* $\frac{1}{8}$ in. to represent a height of 50 feet) are prepared either on a slab board or by rolling out with a rolling pin. The different contour lines are traced from an Ordnance Survey map, and are cut out. A slab of clay is cut to the shape of each contour by placing the shape on the top of the slab and by cutting round it with a sharp pointed penknife. The various pieces are then assembled in correct position and the ridges filled in with very soft clay.

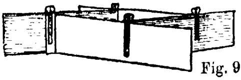


Fig. 9.

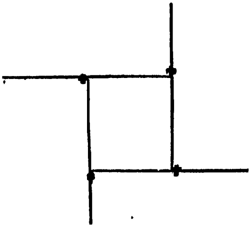


Fig. 10.

Casting Frame.

Simple Casting.—Sometimes the teacher is unable to supply sufficient objects for each pupil, and it is necessary to duplicate some of them. This is easily done by casting in plaster of Paris. The following is a method of making a cast of a lemon.

The Casting Frame.—For a lemon a frame 6 in. square and 4 in. deep is necessary. This could be made of any odd pieces of wood, but if casting is to be done to any extent it is better to make an adjustable frame which will accommodate any size of a model up to certain dimensions. For this purpose procure four pieces of zinc each 12 in. by 4 in. Each piece has one end bent at right angles and projecting $\frac{3}{4}$ in. The frame is held together at the corners by cyclists' trouser clips, and can be adjusted to take any size up to 11 in. by 11 in. See Figs. 9 and 10.

Place the frame on a slate and half fill it with silver sand. Embed the lemon halfway in the sand and gently tap the slate so that the sand lies level all round. Next prepare the plaster. For this purpose take a small basin three parts full of clean cold water. Into this gently pour some plaster of Paris till it just shows over the surface of the water. Stir gently, and when thoroughly mixed and of equal consistency, pour it over the lemon. A sufficient quantity should be taken to cover the highest part of the lemon to a depth of half an inch.

When set (this takes about half an hour) lift the frame and remove the sand. We now have a mould of half the lemon, and

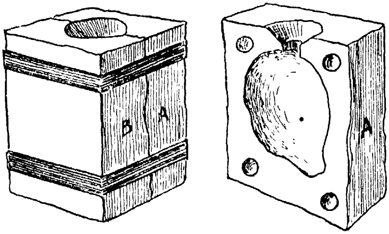


Fig. 12. Fig. 11.

Mould for Casting a Lemon.

if we wish to make a model showing half a lemon on a slab this is all that is necessary. To make this, carefully withdraw the lemon and brush off any sand that may be adhering to the mould. The surface of the mould should be washed over with a solution of soft soap two or three times to prevent the new plaster from sticking to it. Place the mould in the frame and pour in plaster as before. When dry insert the thin blade of a table knife between the two parts and force them asunder.

If a complete model of the lemon is required, replace the lemon in the mould and with the point of a penknife cut conical holes in the mould as shown in Fig. 11. Put soap solution on the holes. Place the mould with lemon into the frame and fill with plaster. When dry separate the two halves and remove the lemon. The top half will be seen to have conical projections which fit in the holes of the other half, thus always keeping the two halves in register. Cut a pouring hole as shown in Fig. 12, and treat all new surfaces with soap solution. When dry, the two halves are placed together and held by rubber bands. The plaster is poured through the pouring hole, and when quite set and hard the two portions of the mould are separated. (N.B.—Give the cast plenty of time to set.) The projecting piece which filled the pouring hole is cut away and the surface smoothed off. The cast may be treated with water-colours and afterwards sized and varnished.

CHAPTER IV.

RAFFIA WORK.

Raffia Work forms a very suitable occupation for young children. The materials required for the work are inexpensive and are easily stored and the tools used are few. Raffia, in natural colour, may be had from most florists and from educational supply stores. It is soft and pliable and needs no preparation. If coloured work is to be undertaken it is quite a simple matter to dye the white raffia in Dolly Dyes. Coloured raffia may be purchased: it is more expensive than the natural colour but the quality and soft texture are worth the difference in price. As purchased from the florist, the raffia is usually in tight plaits. These should be shaken out, tied in bunches, and hung from a hook on the wall so that a pupil can draw out a strand without tangling the rest.

The work to a great extent will be imitative, but the teacher should, wherever possible, get the children to suggest the mode of operation before giving instruction to the class. As far as possible the underlying cardboard shapes of the objects should be cut out by the children themselves. If the children are too young to understand measurement, the teacher may supply a template in zinc or in stout cardboard round which the child will draw to obtain the shape.

BINDING EXERCISES.

1. Circular Mat.
2. Circular Mat with Centre.
3. Octagonal Photo Frame.
4. Long Mat.
5. Needle Case.
6. Square Box.
7. Serviette Ring.
8. Hair Tidy.

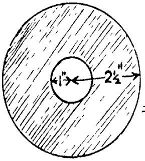


Fig. 13.

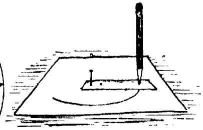


Fig. 14.

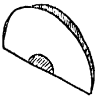


Fig. 15.

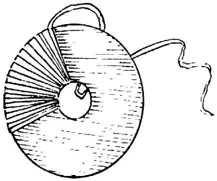


Fig. 16.

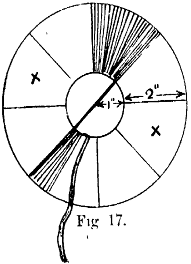


Fig 17.

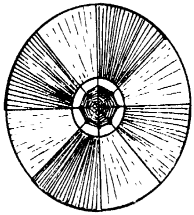


Fig. 18.

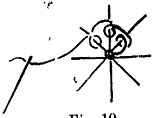


Fig. 19.

1. **Circular Mat** (Natural Colour).

Preparing the Shape.—With template mark out circles shown in Fig. 13. This may be done also by means of the radius strip shown in Fig. 14. Stout cardboard is rather difficult for young children to cut out, particularly the inner circle. This may be overcome by cutting two or more circles in thin cardboard and afterwards pasting them together. To cut out the inner circle fold the cardboard along a diameter and cut the two thicknesses at once, cutting along the semicircle (Fig. 15). When pasting the separate circles together see that the creases do not lie together.

Binding the Model.—Prepare a strip of raffia. Select a piece of even width and about half an inch wide. The raffia will open out easily if it is first damped. No knots should be used in the work. To begin, hold one end on the cardboard, pass the other end through the centre and overlap the first end. Continue the binding, and to finish, thread the end of the raffia through a darning or rug needle and pass it underneath the other strands. It may be necessary to go over the work a second time, each strand overlapping the previous one. Care should be taken to keep the work as flat as possible and to have each strand radiating from the centre of the circle (Fig. 16).

2. **Circular Mat with Centre** (White and Green) (Fig. 18).—Prepare shape to size as in previous model. Divide the circle into eight parts and draw lines shown in Fig. 17. Wrap one section with white raffia and, when complete, carry the strand to the opposite section and bind this. When finished, draw the end underneath. Bind the next section with green and proceed as before.

Centre.—To fill the centre first tie all the cross strands at the middle. The raffia is then threaded through a needle and passed round each cross strand in turn as shown in Fig. 19. Finish with a knot.

3. **Octagonal Photo Frame** (Fig. 20).—Prepare foundation, folding along dotted line to cut out centre (Fig. 21).

Bind as in Model 1. The corners will prove the most difficult part of the exercise. For covering these a broad strip should be selected. Paste the photo on to an octagonal back piece. Paste this to the back of the frame or sew at the corners with thin raffia. Fix loop of raffia to hang the frame.

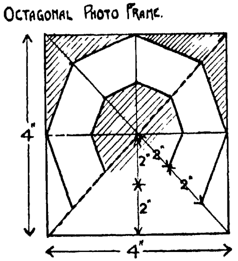


Fig. 21.

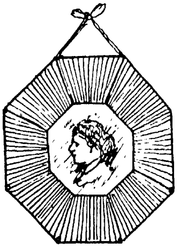


Fig. 20.

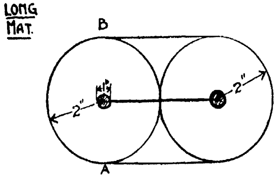


Fig. 22.

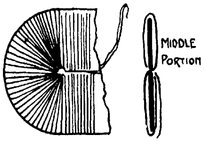


Fig. 23.

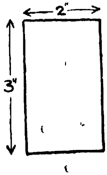
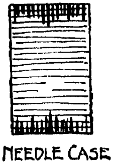


Fig. 25.



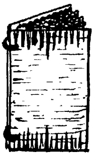


Fig. 24.

4. **Long Mat.**—Prepare foundation, cut along line joining the two small circles (Fig. 22).

Begin binding at *A*. When *B* is reached wrap one turn on the one half, then pass the raffia through the slit and wrap one turn on the opposite half. Proceed in this way till the small circle is reached, then bind as at the other end (Fig. 23).

5. **Needle Case** (Fig. 24).—Cut two pieces of fairly stout cardboard to size (Fig. 25). Bind each piece from end to end, binding across the narrow way. The end strands are held in position by threads of a different colour which are sewn through the cardboard as shown. Cut flannel for the inside and fix the whole together by two or three threads sewn through at points shown in diagram.

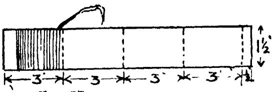


Fig. 27.

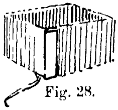
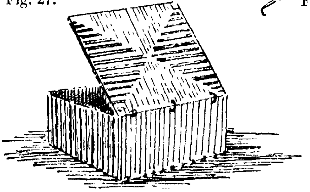


Fig. 28.



SQUARE BOX Fig. 26.

6. **Square Box** (Fig. 26).—Cut strip of cardboard 12½ in. by 1½ in. (Fig. 27). Crease on dotted lines. Bind raffia round the strip and when nearly completed bring the two ends together and bind in position. A stitch at top and bottom of the joint will make it secure (Fig. 28).

Bind a square and sew on to bottom side. Bind a square for lid and finish by stitching on a different colour as shown. To keep the right line of the stitches, a quarter of a square of the same size may be cut out, cutting along the diagonals. This should be held in position when the needle is inserted for each new stitch.

Hinge the lid to the box by stitching as in previous model.

7. **Serviette Ring.**—To make the foundation, cut a strip of thin cardboard 12 in. by 2 in. Cover half with paste and wrap round a round ruler or cylinder $1\frac{1}{2}$ in. diameter (Fig. 29). Bind with raffia as in previous exercises (Fig. 30)

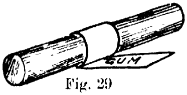


Fig. 29

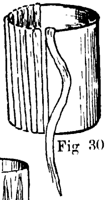


Fig 30.

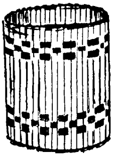


Fig. 31.

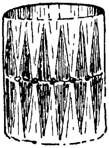


Fig. 32.

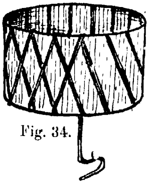


Fig. 34.

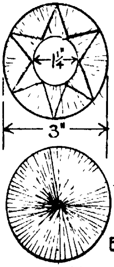


Fig 35.

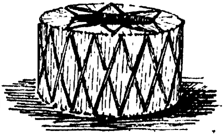


Fig. 33.

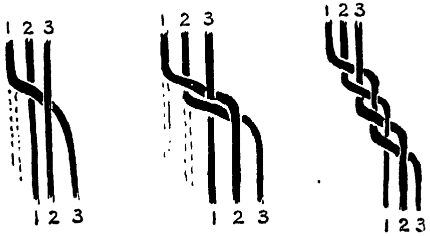
A variety of pretty effects may be obtained by weaving coloured strands with a needle as shown in Fig. 31. Fig. 32 shows a serviette covered first with green raffia then with white raffia on top. A number of strands of white raffia are drawn together and fastened with a knot at the middle.

8. **Hair Tidy** (Fig. 33).—Take a strip of thin cardboard 24 in. by 2 in. and wrap round a 3 in. cylinder (a preserve jar will serve). Gum the end. Bind first with green raffia, then with white and finish as in Fig. 34.

Cut circles for top and bottom. Bind the bottom circle and sew to the sides. Bind the top with white raffia, then overlay an even strand of green raffia as shown in Fig. 35. Sew to sides at the top.

Plaiting Exercises.

Children should be taught first to make a three-strand plait. The thickness of the plait will depend on the number of pieces of raffia in each strand. It is not always possible to get pieces of raffia of even thickness, so that, if necessary, pieces should be added to make all the strands the same size. The strands are all knotted or tied together, and fixed to some object at a height suitable for the child to work at. The principle is the same in all plaits, whether three, four or more strands are employed. Begin with the left hand strand and pass it alternately over and under each succeeding strand to the right. Repeat the operation, always beginning with the left hand strand (Figs. 36 and 37).



THREE STRAND PLAITING

Fig. 36.

When one of the strands begins to get thin or is approaching the end, take a new one, lay it alongside and plait the two together. When two or three rows are completed the ragged ends may be cut off and the new strand will be firmly held. Care should be taken to introduce the new strands at different points in the plait, not at the same place, otherwise the plait will be bulky at that place and weak also

The simple plaits may be fashioned into a number of objects such as reins, curtain-bands, chains, belts, etc.

By sewing the plaits together a number of pretty and useful articles may be constructed.

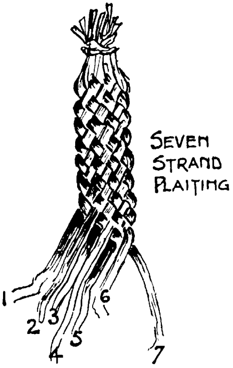


Fig. 37.

A Mat.—For this model the child should first prepare three or four yards of three-strand plait. Place the knot at the centre and coil the plait round it, keeping the plait flat with the edge against the knot. The first stitches should pass right through the plait and the knot, from side to side. With the later stitching, the edges of the plait are stitched together (Fig. 38). The stitching should be done with fine raffia, on one side only, and should be shown as little as possible. To flatten the mat when finished damp and press between two boards. The edge of the mat may be finished off in a variety of designs, but care must be taken to begin with sufficient length of plait to complete the added design (Figs. 39).

Baskets.—A number of pretty baskets and trays may be constructed by continuing on the lines of the mat. When a portion has been stitched sufficient for the base, the new row is stitched on the top instead of at the side as before. The stitching is continued with the plait in a vertical position or sloping as may be required according to the shape of the basket being made. The top of the basket is finished off by stitching a row on the outside of the top row, making it thicker and firmer, or it may be finished by button-holing round the top (Figs. 40).

Dolls hats are made in a similar fashion, the position of the plait, when being sewn on, determining the shape of the finished article.

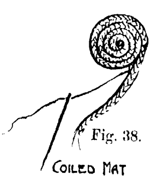
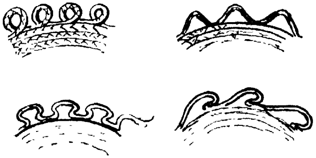


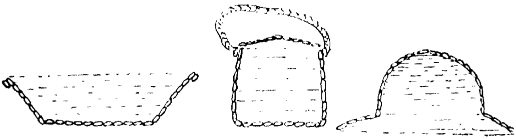
Fig. 38.

Coiled Mat



Mat Edgings

Figs. 39.



Arrangement of Plaits for Trays, Baskets & Hats

Figs. 40.

Weaving.

A number of small looms are on the market, but quite satisfactory work can be done on one made from a piece of stout cardboard. The weaving can be done in a variety of materials—raffia, wool, and macramé thread being the most suitable.

Mat (woof cut into short lengths). Raffia.—Prepare a loom by cutting a piece of cardboard to dimensions shown (Fig. 41). If the children are too young to undertake the drawing correctly, the teacher can cut out a specimen and the child can then use it as a template and draw round it. Tie a loop at one end of the warp and loop it on the end projection. Wind on the warp as shown, on one side of the cardboard only. When a new strand is required, tie with a knot in the middle of the cardboard, not at the edge. Finish by looping over the last projection and tie a loop.

For the woof, cut a number of pieces of raffia 7 in. long. To carry the woof across the warp a long needle will be required. Thread one of the pieces of raffia and lace it across the warp, passing alternately over and under the strands. Repeat the process, this time passing it under and over. Continue and keep the fabric close up to the top and keep even lengths projecting at each side. When finished, the mat can be taken off by slightly bending the cardboard. The free ends can be knotted together to form a fringe.

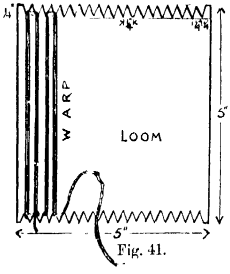


Fig. 41.

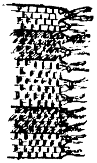


Fig. 42.

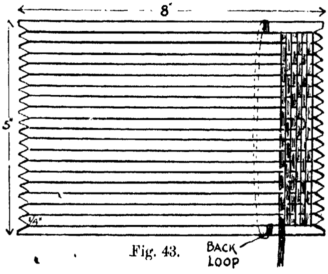


Fig. 43.

The same exercise can be repeated, introducing bands of colour as in Fig. 42.

Mat (continuous woof). Raffia.—Prepare a loom to dimensions shown (Fig. 43), and string it as in previous exercise.

Start the weaving at one end half way across, passing the needle alternately over and under the warp. Keep the weaving close up and straight, pushing it up with the needle where necessary. The fabric will tend to get narrower towards the middle. This may be avoided to a certain extent, by joining the outside strings of the warp by a loop passing round the back of the cardboard. This loop is kept close up to the weaving and is moved along as the work progresses. Always finish off a strand of the woof in the middle of the material, not at the sides, and commence a new strand in the same way. When the loom is full, bend the cardboard in the middle and slip the fabric off each end. Any loose ends should be trimmed off or should be sewn into the fabric.

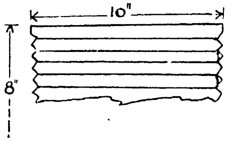


Fig. 44

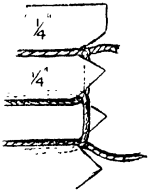


Fig. 45.

Bag (fabric forming a continuous band).—Prepare a loom 10 in. by 8 in., notches ¼ in. apart, on short ends (Fig. 44). Wrap the string of the warp as shown in Fig. 45. Note that the string is passed under the loop before passing to the next notch.

Weave both sides as in previous exercise, filling first one side then the other.

When completed, break away the cardboard foundation and stitch up the bottom of the bag. Sew on handles of three-strand plait of raffia.

Bag (without seam).—Prepare a loom 10¼ in. by 8¼ in., notches ¼ in. apart on long sides with spaces at ends of ⅛ in. (Fig. 46).

Wrap the string of the warp as shown in Fig. 47.

Note that the string does not pass under the loop as in previous exercise, so that when the weaving is finished each loop will lift off, leaving the top open.

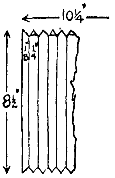


Fig 46.

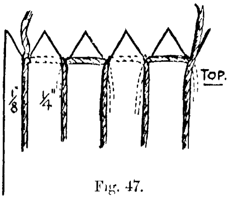


Fig. 47.

Begin the weaving at the top (loop side) and carry the woof round both sides, thus:—First line on side *A*; with same woof weave first line on other side *B*; turn the loom and continue to weave second line on side *A*, then second line on side *B*.

When finished, lift off the loops and withdraw the cardboard foundation. Add handles and strengthen the top with a row of blanket stitching.

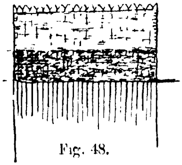


Fig. 48.

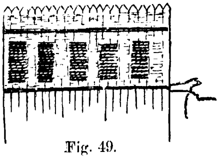


Fig. 49.

Pattern Weaving.

Horizontal Stripes (across the warp, Fig. 48).—These are obtained by taking a different coloured material for the woof. The position of the bands should be marked on the cardboard foundation or on a piece of paper placed under the warp.

Vertical Stripes (with the warp, Fig. 49).—Use two different colours for the woof, weaving each colour alternately. The stripe is more pronounced if two threads of the warp are taken at a time.

Patterns.—There are modifications of the vertical style, and to be effective need a fairly close warp. A few examples are shown in Fig. 50.

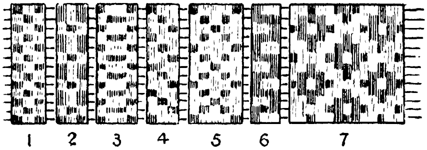


Fig. 50.

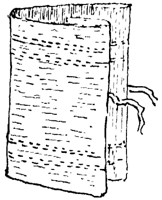


Fig. 51.

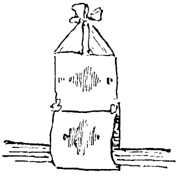


Fig. 52.

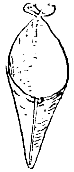


Fig. 53.

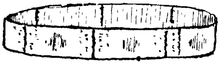


Fig. 55

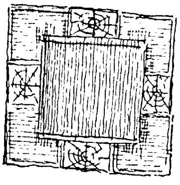


Fig. 54.

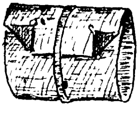


Fig. 56.

Making up.—The fabrics obtained by the above methods can be made up into a variety of objects. They can be sewn together to form book covers (Fig. 51), taper holders (Figs. 52 and 53), table centre (Fig. 54), curtain band (Fig. 55), Wallet (Fig. 56).

CHAPTER V.

BASKET WORK.

COILED BASKET WORK.

This work consists of two portions—the coil which is wound spirally, and the stitch which holds the coil in place. For the coil, various materials may be employed, such as rushes, grass, raffia, or cane.

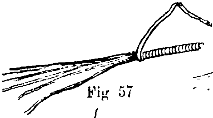


Fig 57

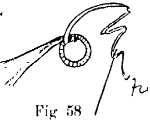


Fig 58

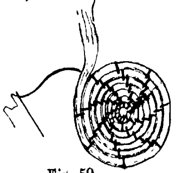


Fig. 59.

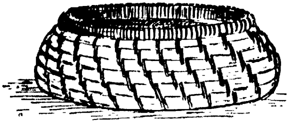


Fig. 60.

Basket (Simple Coil with raffia foundation).—For the coil take a few strands of natural coloured raffia. Bind these for a distance of one inch with a strand of coloured raffia, blue is very effective (Fig. 57). Loop the coil to form a ring (Fig. 58). Thread the coloured raffia through a needle and sew this ring firmly and evenly all round. The coil is worked round the centre, and is held in position by the stitch which passes round the coil and through the previous round. Each stitch should be put through on the left of the stitch underneath, and the same number of stitches should be used for each round. This will give the effect of curved ridges radiating from the centre (Fig. 59). When the base has been formed, the coil should be worked on the top to form the sides of the basket. The top row of the basket can be bound firmly by sewing all round with stitches close together (Fig. 60).

Basket (Simple Coil with cane foundation).—Instead of raffia for the coil, a single cane is used. A long cane of No. 3 should be selected and tied up in a coil with a loose end of about eighteen inches. Taper the end of the cane and soften it in hot water. Proceed with the centre as in previous exercise. In this case the stitch cannot pass through the coil, but is made to pass under the preceding cane and over the new cane. As before, care should be taken to pass the stitch to the left of the stitch beneath, and to use the same number of stitches in each round.

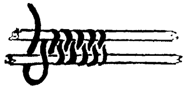


Figure 8 Stitch.

Fig. 61.

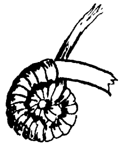


Fig. 62.

Basket (Figure 8 Stitch, Pima Coil).—The coil may consist of either raffia or cane. Make a centre as in previous exercises. The stitch employed in this basket follows the outline of the figure 8 (Fig. 61). In commencing the second row after completing the centre, the needle is passed (1) between the two canes, (2) over and round the outer cane, (3) back through the two canes, (4) over and round the inner cane (Fig. 62). This is continued with the whole coil, and it will be seen that whilst the new coil is being covered for the first time, the preceding coil is being covered for the second time.

Basket (Lazy Squaw Stitch).—A length of No. 4 cane is used for the coil and a centre made as in previous exercises. The stitch is illustrated in Fig. 63. In commencing the second row, the needle is taken (1) over the two rows, (2) once round the outer cane, (3) under the inner cane, and continued as (1), (2), and (3). Care should be taken to keep the stitches pointing to the centre (Fig. 64). As the work proceeds each row will require new stitches. These can be added by putting two stitches into one hole (Fig. 65).

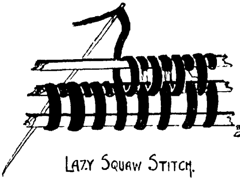


Fig. 63

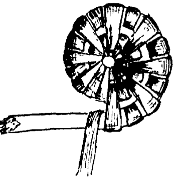


Fig. 64.

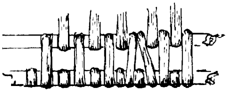
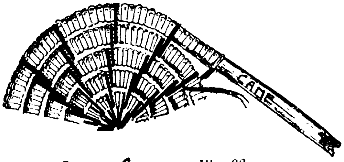


Fig. 65.

Basket (Peruvian Coil, Fig. 66).—This is very similar to the Lazy Squaw Stitch. The centre and first row are worked as in the previous exercise. In the second row the raffia is bound twice round the outside cane before stitching to the under cane. With the third row wrap three times round the new cane between the stitches. As each row is added the number of wrappings is increased. The thickness of the raffia will influence the number of wrappings between the stitches. The aim should be to keep the stitches in line as nearly as possible. If the distance between the stitches becomes too great to keep the basket firm, a new stitch may be introduced half way along the wrapped portion.

Handles.—These may consist of plaits of raffia sewn to the basket (Fig. 67), or of pieces of cane sewn on to the top row as shown in Fig. 68, and afterwards wrapped closely with raffia. Fig. 69 shows another form of handle which is not rigid.

Pattern weaving.—The introduction of pattern in the weaving of the basket is very interesting and attractive, but is difficult for small children and is hardly within the scope of this small work. The best plan is to study and copy good examples of basketry. With young children the outline of the basket should receive most attention, and an attempt should be made to obtain beauty in the symmetry and shape itself, rather than in the contrast of colour.



Peruvian Coil —— Fig. 66.

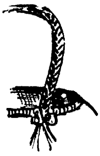


Fig. 67

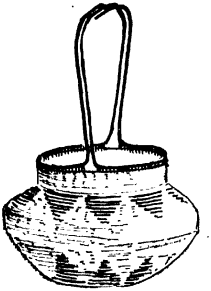


Fig. 68.

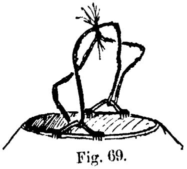


Fig. 69.

Cane Basket Weaving.

The material used is known as Centre Cane. It may be obtained in various thicknesses, but Nos. 2, 3, and 4 are most suitable for small baskets. For large baskets such as paper baskets Nos. 5 and 6 are suitable. In the dry state the cane is very brittle, and it should be thoroughly soaked before using.

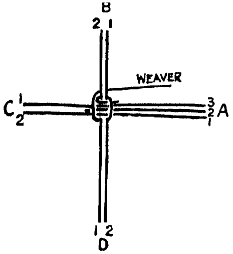


Fig. 70.

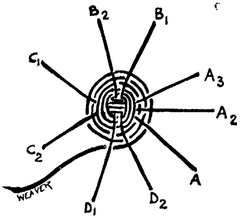


Fig. 71.

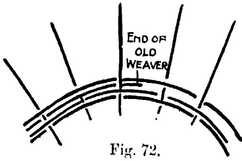


Fig. 72.

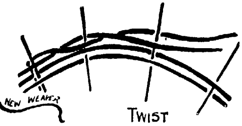


Fig. 73.

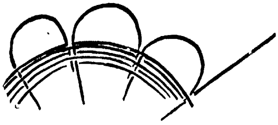


Fig. 74.

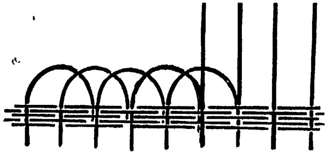


Fig. 75.

A Cane Mat (odd number of spokes).—For the spokes take four pieces of No. 3 cane, each 12 inches long, and one piece 7 inches long. For the weaver take a length of No. 2. Wrap the weaver in a coil and tie with raffia. Soak the spokes and weaver for about ten to fifteen minutes in luke-warm water. Arrange the spokes as shown in Fig. 70, the horizontal spokes on top of the vertical spokes. Place one end of the weaver at *A*, Fig. 70, pass it round the back of *B*, over *A*, under *D*, over *C*, and continue for three rows, keeping the weaving close. This forms the centre of the mat. Now separate the spokes and bend them where necessary till they are evenly spaced.

The weaver is now carried alternately over and under the spokes (Fig. 71). The weaver must be pressed down every time and should be held in position by the forefinger of the left hand. Continue the weaving as closely as possible, and keep the spokes evenly spaced. When introducing a new weaver, lay it alongside the old weaver for two spokes, and continue the weaving as if it were the original weaver (Fig. 72). All ends should be kept on the same side, and can be cut off short when the work is finished. The mat should be woven till it is 3½ inches diameter, then finished off as follows: Take a piece of No. 2 cane about twelve inches long and insert one end behind one of the spokes. The new weaver and the old weaver are twisted round the spokes as shown in Fig. 73. This makes a firm finish and prevents the last row of weaving from unwinding. The ends of the twist are woven through the first bend of the twist and are cut short, or may be pushed down about one inch by the sides of the spokes. Soak the mat again to soften the cane. Cut all the spokes the same length if they are not so, and finish off in the trellis pattern shown in Figs. 74 or 75. If difficulty is found in pushing the ends in, an opening may be made between the canes by means of a large knitting needle or a skewer.

Basket. 8 pieces No. 3, each 16 inches long,
1 piece No. 3, 9 inches long,
Weavers of No. 2.

Soak the cane thoroughly. Arrange as in Fig. 78, and form the centre as in previous exercise. After weaving three turns round, separate the spokes (Figs. 76 and 77), and weave as before till the circle is 3 inches across. Then take a new weaver and make one row of twist as in finishing previous model. Soak the whole till quite pliable, then bend all the spokes up gradually to form the sides. Continue the weaving as before, but do not pull the weaver too tightly or the spokes will be drawn in. Keep an eye on the shape of the sides, and when about 2½ inches high,

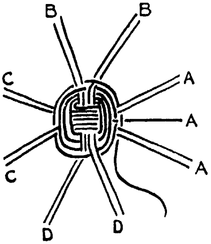


Fig. 76

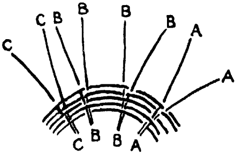


Fig. 77.

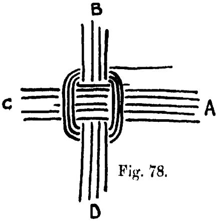


Fig. 78.

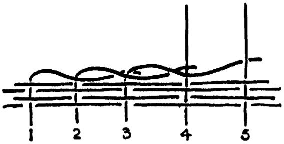


Fig. 79.

begin to pull the weaver tightly so as to draw the spokes in a little. Continue for 1 inch, and then finish off with a row of twist. Cut the spokes to equal length. Then finish as shown in sketch (Fig. 79). No. 1 spoke is passed in front of No. 2 and behind No. 3, and repeat this all round. Near the end of the border the spokes will have to be pushed under the other spokes which are already bent down, but the pattern must be continued as shown above.

The above basket may be improved by weaving coloured canes into it to form bands. The canes may be dyed by means of Dolly Dyes.

Shallow Basket (even number of spokes).
8 pieces No. 3 cane, each 18 inches long.
Weavers of No. 2.

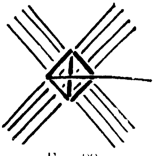


Fig 80

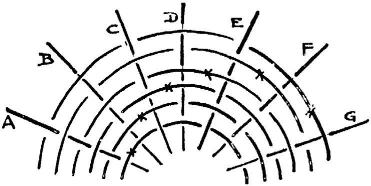


Fig. 81.

Four spokes are placed vertically and the other four across them horizontally at the middle. Bind them together as in previous exercise. Fig. 80 shows another way of binding the centre. This gives a firm beginning, and it is immaterial how it is obtained provided it is symmetrical and the same on both sides. The weaving should be continued for four rounds, then the spokes should be divided into pairs and woven over and under for four rounds. It will be noticed that each row is the same as the previous one, owing to the fact that the number of spokes is even. The next step is to divide the pairs and weave over and under each spoke. At the end of the first round carry the weave over two spokes, so that the weave of the second round will differ from the first. This must be repeated at the end of each successive row. The two spokes crossed over in the second row should not be the same as those crossed in the first row, *e.g.* if the spokes are *A*, *B*, *C*, *D*, *E*, in the first row *A* and *B* will be crossed; in the second *B* and *C*, in the third *C* and *D*, in the fourth *D* and *E*, and so on (Fig. 81).

Weave a base of 3½ inches diameter and add one row of twist. Turn up the sides slightly and continue the weave as before for one inch. Take a coloured cane and weave three rows, going under and over the same spokes. Then pass over two spokes and weave three rows over and under the same spokes. Again pass over two spokes and weave three rows over and under the same spokes. This will give three ornamental bands, the top one being the same as the bottom one (Fig. 82). Continue the ordinary weaving as before, working to obtain the shape shown in section Fig. 83. When completed finish off in the following manner: Add one row of twist. Soften the spokes; take each one in turn, bend it down, and weave it over and under the

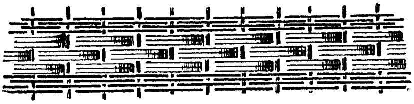
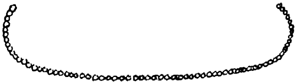


Fig. 82.



SECTION OF SHALLOW BASKET

Fig. 83.

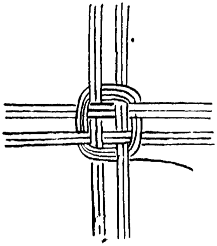


Fig. 84.

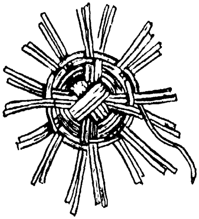


Fig. 85.

spokes to the right, finishing on the inside. The first one should be woven loosely, so that the last ones can be easily pushed into position.

For larger baskets more spokes and of a heavier gauge will be required. Twelve spokes may be arranged as shown in Fig. 84. Sixteen spokes are shown in the centre of Fig. 85.

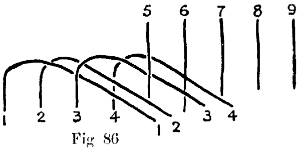


Fig 86

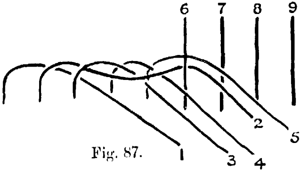


Fig. 87.

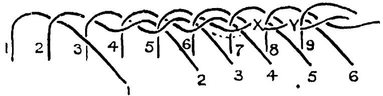


Fig 88.

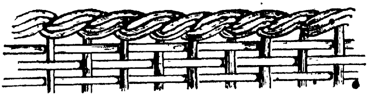


Fig. 89.

Rope Border.—This is a useful and strong finish for the top of a basket. The spokes should be quite damp and should be long enough to pass over five successive spokes.

First Stage.—All spokes are worked to the right. Bend No. 1 in front of 2, behind 3, then bend 2 on top of it. Continue by bending 3 in front of 4, behind 5, then bend 4 on top of it. 1 and 2, and 3 and 4 now form two pairs (Fig. 86). Take the upper one of the left hand pair, No. 2, pass it in front of 5, behind 6, and bend 5 on top of it. 5 and 2 form a new pair, with 5 on top (Fig. 87). Take the upper one of the left hand pair No. 4, pass in front of 6, behind 7, and bend 6 on it. Continue all round, and when back to the beginning the first four must be drawn out and made to correspond with the rest of the twist. Fig. 88 shows the twist at this stage.

Second Stage.—Take 3 and pass it over 7 and through in front of 8 at the place marked *X*. Take 4, pass over 8 and through in front of 9 at *Y*. Continue all round in the same way and so obtain the finished edge shown in Fig. 89. When the basket is quite dry the ends should be trimmed off.

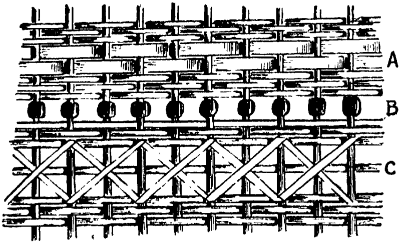


Fig. 90.

Ornamental work.—Split cane (flat in section), raffia and beads may be introduced to ornament basket work. Fig. 90A shows bands of split cane introduced to break up the plain weaving.

Fig. 90C shows suggestions for combining coloured raffia and cane in basket work. Fig. 90B shows the addition of coloured glass beads to give effect.

CHAPTER VI.

PAPER WORK AND CARDBOARD MODELLING.

General Method.—For good results the class should not exceed 30 pupils, otherwise the teacher will be unable to attend to each pupil individually. A larger class would mean slower progress and loss of interest on the part of the children.

Material, when purchased, should be cut to sizes suitable for each model. This is a great saving in time required for distribution, in material, and in accommodation required for storage. In the lower classes the pupils should be supplied with, or should make, brown paper envelopes in which to place their unfinished work. In the upper classes a box, about 12 in. × 9 in. × 2½ in., may be made for the same purpose.

In the lower classes the work, to a great extent, will be imitative—the teacher performing an operation and the children copying it. This subject calls for very clear and concise instruction on the part of the teacher. There must be no doubt in the child's mind as to what he is required to do, as a false cut may ruin the whole model. In demonstrating the work to the children it is a good plan to pin a large sheet of brown paper on the blackboard and to make the required drawing on this. Then, when the cutting and folding are demonstrated, the teacher can cut the paper and show the various operations much more clearly than with a small model.

In the upper classes the analytical method should be adopted to a great extent. Specimen models should be handed round for inspection. In some cases a model may be broken down, and then, from their observations, the children should suggest methods of building up the *net.* The different suggestions should be discussed, and the most suitable adopted. Much of the educational value of the work is lost when it is treated mechanically. The pupil should see the reason for every step, and should quite clearly see where each part fits in the finished model. The measurements should be taken from the model itself by the children.

Geometrical drawing forms the basis of many of the models, and the accuracy of the model depends to a great extent on correct drawing. At the earliest stages the child should be taught to use the ruler correctly, both for ruling and for measuring. The ruler used in the lower classes should be clearly marked, and should contain only those fractions of an inch used in the measurements. The ruler usually found in the hands of the pupil is far too crowded with measurements, and only leads to confusion. In the upper classes angle templates and set-squares can be made by the pupils themselves, the angles being obtained by paper folding. The radius strip can be used instead of the compasses where expense is objected to.

The geometry of the subject should not be neglected. The various operations in drawing the *net* should be considered in themselves apart from the model, so that, whilst the child is developing hand and eye, he is also studying applied geometry. In the upper classes solid geometry should be taught in conjunction with the work. Plans and elevations should be taken with models which are suitable. This will greatly assist in the woodwork taken later.

Accuracy is a very important part of the work. No detail of the work should be done in a careless manner, even if covered up in the finished article. Just how much accuracy the teacher will insist on will depend, to a great extent, on the type of child being taught and on the size of the class. Too high a standard makes the work tedious; too low a standard robs the subject of much of its educational value. Careful supervision on the part of the teacher, at each step of the work, will prevent a great deal of inaccuracy and also prevent disappointment to the pupil.

The subject provides ample opportunity for correlation with other class subjects, particularly arithmetic and mensuration. The skilful teacher will find plenty of examples for concrete arithmetic, and the geometrical solids will serve as excellent models on which to base calculations in mensuration.

Selection of Models.—Models should not be taken haphazard: some definite principles should decide the order in which the models are taken. The work will necessarily be simple at first, increasing in difficulty as the pupil gains dexterity. There should be continuity in the work. Each new model should if possible be linked to the previous ones, and should embody some of the exercises already mastered. Difficulties should be introduced gradually. The difficulty of a model will depend on (*a*) material employed, (*b*) tool manipulation, (*c*) geometrical construction.

(*a*) *Material Employed.*—The material must be suitable to the exercise for which it is intended, and should be of such a texture and weight that the child is strong enough in the fingers to be able to work it. Some materials are much easier to work than others, *e.g.* some covering papers soil much easier than others, and are more difficult to handle when covered with paste.

The size of the surface being covered also makes a difference in the difficulty of the exercise. Curved surfaces are more difficult to work than flat surfaces.

(*b*) *Tool Manipulation.*—The child finds it easier to cut with the scissors than with the knife. A through cut is much easier than a stopped cut. In cutting curves with the scissors, a large curve is cut more evenly than a small curve. Cutting curves with the knife is a difficult operation, as the child has to do it without an edge to guide him.

(*c*) *Geometrical Construction.*—The square forms a very suitable beginning for the child. By folding he obtains the rectangle and the triangle. From these, by arrangement, he can obtain the rhomboid, the rhombus, the octagon, the hexagon, and so on. There should be some connection between the basal figures as far as possible: the model should not be based on a totally new figure unconnected with the previous one.

The difficulties of the model, judged from the above points of view, should guide the teacher in arranging a series of models. The models should be interesting to the children, and should be useful. Purely geometrical models, *e.g.* the cube, or the square pyramid, may be useful if they are made to illustrate some formula in mensuration, but, apart from that, they are uninteresting to the children. A slight modification of the model will often make it more interesting from the child's point of view without injuring it as a geometrical solid; *e.g.* a square prism, left as such, is uninteresting to the child, but if made so that a portion of it opens to form a lid, he finds a use for the model, and a new interest in it is created.

Original work is rather difficult in cardboard modelling. The best plan is for the teacher to work a type with the pupils, and then to give them an opportunity to modify this type to form a new model.

Material and Tools.—For paper work and cardboard modelling the tools and materials are few and inexpensive. Whilst much may be done with material supplied by the children themselves, yet it is most satisfactory in the end to purchase it, as much of the difficulty of the work depends on the texture and thickness of the material employed.

The paper used for tearing exercises should be carefully selected, as many thin papers do not easily tear in a straight line.

Manilla paper serves as a link between the paper work and cardboard work. It is too strong for tearing and is only suitable for work with the scissors.

Tinted boards are used in the lower grades where the models are not covered with fancy papers. These boards can be obtained in different weights, and the earliest exercises should be worked in very thin boards, not much heavier than manilla paper. Heavier boards will be used in subsequent stages as the strength of the child's fingers increases.

Yellow strawboard or white pulpboard serves as a foundation for models in the higher stages. For binding the parts together, bookbinder's calico is used. If the binding is seen in the finished model, bookbinder's cloth may be substituted. Fancy papers and cloths for covering and for binding may be obtained from most dealers in educational supplies, and should be carefully selected with regard to their thickness, colour, and design.

In the lower stage cutting is done with the scissors. These should be about 4½ in. long with pointed ends. Safe scissors (having the points rounded off) encourage careless handling in school, and so may lead to possible accidents at home with the ordinary pointed ones.

When folding cardboard it is first necessary to make a half-cut. In the lower stages, where the material is thin, scoring with a needle serves the same purpose. A very handy tool for this operation is the kindergarten pricker (Fig. 91); a large darning needle, or a knitting needle ground to a point, will serve equally well. These can be used against an ordinary straightedge.

For cutting the thick cardboard in the higher stages a special knife is employed. The London pattern (Fig. 92) has a straight cutting edge, whilst the Leipzic pattern is curved (Fig. 93). The latter form is the better in practice, although the former is more easily sharpened. Both forms are also made with a button on the back to prevent the blade from hurting the finger when pressure is applied (Figs. 94 and 95). A whetstone used with water is required for sharpening the knives.

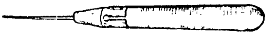


Fig. 91.

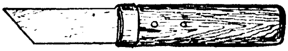


Fig. 92.

London Pattern
C.M. Knife

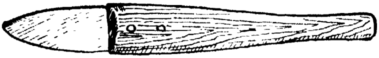


Fig. 93.

Leipsic Pattern
C.M Knife.

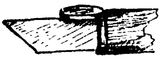


Fig. 94.

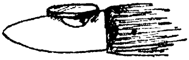


Fig. 95.

When folding strawboard and the heavier boards, the material is first cut halfway through ("half-cut"). The fold should be made with the cut on the outside. The folded portion should then be pressed down flat, either with the ruler or with a special bone folder supplied for the purpose.

Various forms of straight-edge have been devised; sections of a few are shown in Fig. 96. The ordinary steel rule of $\frac{1}{32}$ in. thickness is not very suitable, as the knife is apt to slip over the edge. To prevent this a broad raised cutting edge is necessary. The "non-slip" safety straight-edge is a very satisfactory tool. It grips the material well, has a broad cutting edge, and is quite safe for the children to use.

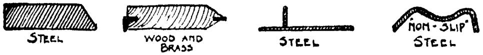


Fig. 96.

To protect the bench when cutting, a slab of some material is necessary. Beech boards are good but are cumbersome. Zinc slabs, about 15 in. by 10 in., are very satisfactory both in use and in cost. A piece of thick leather board or grey board may be used. It is less expensive than the zinc, but will not last as long.

For fixing the different parts of the models together, various methods have been adopted. In some schemes *nets* are designed so that the different parts lock into each other. This method is satisfactory up to a point, but it limits the number of models which can be made. Fixing with small paper fasteners, wire staples, string, and ribbons tied through holes punched in the material, are different devices adopted for overcoming the difficulty of the adhesive. Glue, although quite satisfactory in skilful hands, is not suitable for class purposes. A preparation known as Pine Gum gives very good results. It is a stiffish white paste. Used thick, it holds stout strawboard; diluted with water, it forms an excellent adhesive for papers. The gum may be applied with a small strip of cardboard or with a brush, which should be stiff and not too long in the bristle. The adhesive is best distributed in small glass bottles with screwed tin lids.

Scheme of Educational Handwork in Paper and Cardboard Modelling.

STAGE I.—PAPER TEARING, CUTTING, AND MOUNTING.

The work of this stage will consist of tearing and cutting shapes of natural objects and mounting them. The Nature Study lessons will provide a number of suitable studies to begin with, the earliest being symmetrical shapes.

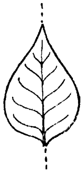


Fig. 97

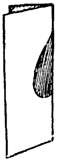


Fig 98.

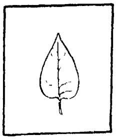


Fig 99.

Simple Leaves.—Take a simple leaf like the *lilac* or the *beech*. Supply specimens to the class, and lead the children to see that the leaf is symmetrical about the mid-rib (Fig 97). Fold a piece of thin green paper down the middle. Fold a lilac leaf along the mid-rib. Place the folded leaf on the paper, with the mid-rib on the folded edge of the paper, and mark round the edge with a pencil (Fig. 98). Tear along the line, open out, and compare shape with original leaf. In later exercises the pencil line should be omitted and the children should tear out a mass corresponding to the half-leaf. These exercises should be mounted on brown paper and the veins marked in with a pencil (Fig. 99).

Compound Leaves (Fig. 100), *e.g.* shamrock, laburnum, rose, chestnut, ash. These may be treated in the same way, each leaflet being torn separately and mounted in position on a stem drawn in crayon on a brown paper mount.

Fruits and Seeds.—More difficulty will be experienced in making these shapes. Leaves are practically flat surfaces, whereas in the case of a fruit a child is representing a round surface on the flat. Examples to be worked :—Orange, apple, plum, pear, carrot, sycamore fruit, fir cone. Suitable coloured

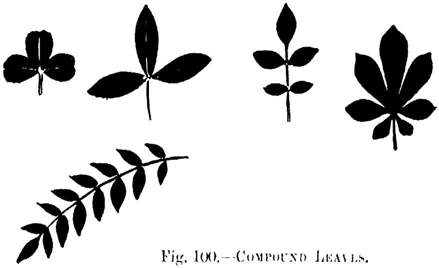


Fig. 100.—Compound Leaves.

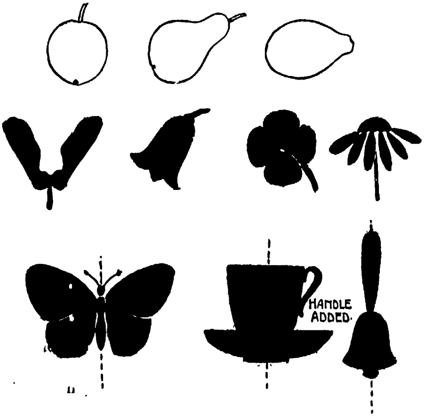


Fig. 101.

papers should be used and lines added where necessary with crayons or pencil. Flowers, insects, fish, toys, and tools may also be used as exercises to copy, using the scissors for cutting long narrow portions (Fig. 101).

Objects which are Unsymmetrical.—Unsymmetrical objects are more difficult to reproduce. The correct proportion of the different masses should first be roughly cut out, the details of outline being worked in afterwards, *e.g.* snail and shell (Fig. 102).

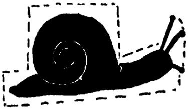


Fig. 102.

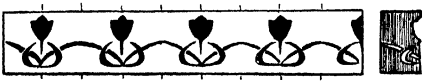


Fig. 103.

Design.—Simple designs might be made by arranging a repeat of the leaf shapes obtained in the above exercises. Simple borders can be made by folding a strip, about 10 in. by 3 in., into eight. Cutting on the folded edge gives a repeat which gives pleasing results if suitably arranged. Thin paper is necessary, otherwise the cutting will be too heavy for the young children (Figs. 103).

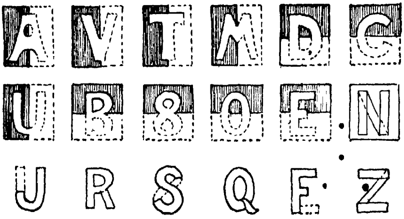


Fig. 104.

The Alphabet.—A useful set of tearing exercises may be made from the alphabet. Many of the letters are symmetrical about an axis, and others can be easily built up (Fig. 104). The class in word building will find plenty of use for these models when finished. To obtain uniformity one size of paper, about 4 in. by 3 in., should be used, and the letter should be as large as the paper will allow.

STAGE II.

Tools and Materials Required.—Each pupil requires a pair of scissors, an H.B. pencil, a 12 in. ruler marked with quarter inches, a pot of paste, and a brush. Different tints of paper should be used for each exercise, and the piece supplied to the pupil should be larger than the basal figure, *e.g.* a model based on a 4 in. square should be cut out of a 6 in. square of paper. A 4 in. square should not be supplied to the pupil, as the correct construction and cutting out of the square is a very important part of the exercise.

MODEL 1. **Water Pocket.** (10 in. by 8 in., white paper required.)

This is an exercise in folding and tearing a square.

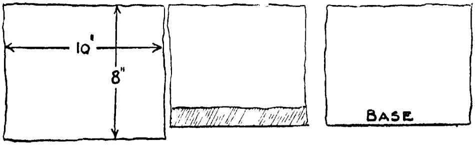


Fig. 105.

(*a*) *To obtain Base.*—Place paper in position shown. Fold lower edge and crease. Tear off strip neatly, leaving a straight edge. Write BASE over this line (Fig. 105).

In tearing, the paper is held with ridge towards operator, as shown in sketch. Start the tear with the fingers close together, then place hands in position shown, and tear with a gentle, even pull (Fig. 106).

(*b*) *To obtain Sides.*—Fold sides at right angles to base. Crease and tear off (Fig. 107). To fold at right angles, see that the lower edge of the folded portion coincides with the base line.

Fold the base on to left side and mark off length of base along the side. Repeat on right side, making both sides equal to base (Figs. 108 and 109).

(*c*) *To obtain Top Side.*—Fold through points marked on the sides. Crease and tear off (Fig. 110).

The child should now test the result by folding opposite and adjacent sides together and comparing their lengths. The angles should be treated in the same way. "Half" and "quarter" can here be demonstrated.

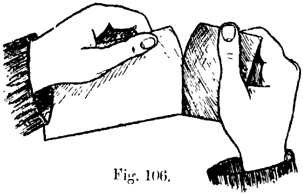


Fig. 106.

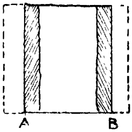


Fig. 107.

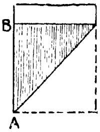


Fig. 108.

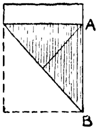


Fig. 109.

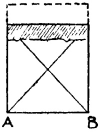


Fig. 110.

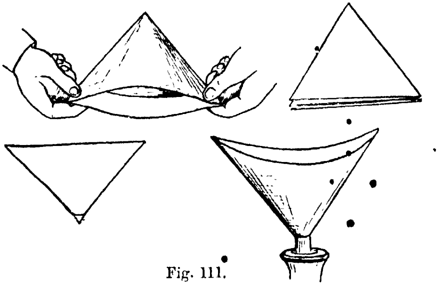


Fig. 111.

By folding as shown (Fig. 111) the drinking cup can be formed, or by tearing off the point it can be used as a funnel.

MODEL 2. **Mat** (Fig. 112). (Required 9 in. square white, 8 in. square green paper.)

Fold and tear a 7 in. square of white paper, and 6 in. square of green paper.

Fold the green square along the diagonals through stages shown.

With pencil draw design and cut out with scissors. Mount the green square on white one with equal margin round the edge.

Model 2 , Mat —

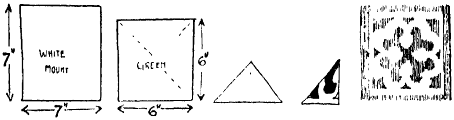


Fig. 112

Model 3 Wall Pocket.

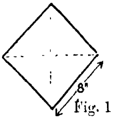


Fig. 113.

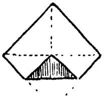


Fig. 114.

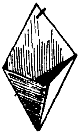


Fig. 117.

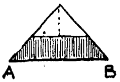


Fig. 115.

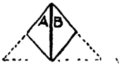


Fig. 116.

MODEL 3. **Wall Pocket.** (Required 10 in. square, pink paper.)

Fold and tear an 8 in. square (Fig. 113).

Fold a corner to middle of square and crease (Fig. 114).

Fold on diagonal parallel to line obtained (Fig. 115).

Fold corners *A* and *B* to top as shown (Fig. 116).

Tuck *A* and *B* inside the pocket and crease (Fig. 117).

MODEL 4. **Double Hanging Pocket.** (10 in. square, pink paper.)

Fold and tear an 8 in. square.

Fold opposite sides together and crease. Fold and crease along one diagonal. Reverse the folding so that paper creases either way (back or front).

Place paper in position shown (Fig. 118). Bring ends of diagonals *A* and *B* together as in Fig. 119. Pass ends *A* and *B* across each other to position shown (Fig. 120). Fold ends *A* and *B* over inside the pocket. Pierce holes and hang with loop of cord (Fig. 121).

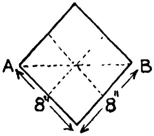


Fig. 118.

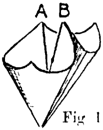


Fig 119

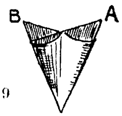


Fig. 120

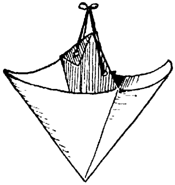


Fig. 121.

5. TRIANGULAR BAG

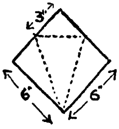


Fig. 122.

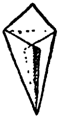


Fig. 123.

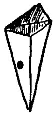


Fig. 124.

MODEL 5. **Triangular Bag.** (Required 8 in. square, brown paper.)

Fold a square 6 in. side. Cut out with scissors.

Set out middle points of two adjacent sides.

Fold along dotted lines in sketch (Fig. 122).

Draw pencil line from top to bottom and cut off shaded portion (Fig. 123).

Gum side flaps in position (smaller flap on top) (Fig. 124).

Point of top when folded down should fall on centre line.

6. WINDMILL

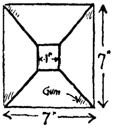


Fig 125.

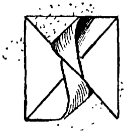


Fig. 126

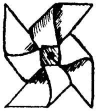


Fig. 127

7 SQUARE TRAY

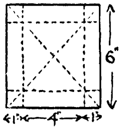


Fig 128.

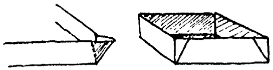


Fig. 129

MODEL 6. **Windmill.** (9 in. square, stiff coloured paper.)

Fold and cut out 7 in. square. Fold along diagonals.

Cut out two squares of paper 1 in. side.

Gum one small square in position (Fig. 125), with corners on diagonals.

Cut along diagonals to corners of inner square.

Gum corners shown shaded (Fig. 125) and fix each on opposite corner of small square (Fig. 126).

When firmly fixed, gum remaining small square in middle. Make hole for pin (Fig. 127).

NOTE.—Do not crease when folding points over, and fix one corner at a time, holding in position till fixed.

MODEL 7. **Square Tray.** (8 in. square, stiff coloured paper.)

Fold and cut out 6 in. square.

Fold along diagonals.

Measure 1 in from each corner and fold to obtain dotted lines in sketch (Fig. 128).

Fold corners of tray and fix with gum (Fig. 129).

8. TRAY WITH FLAPS

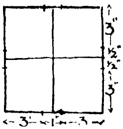


Fig. 130.

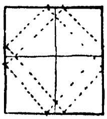


Fig. 131.

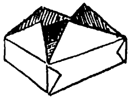


Fig. 132

9. LETTERETTE

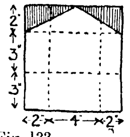


Fig. 133.

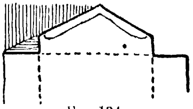


Fig 134.

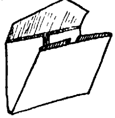


Fig. 135.

Fig. 136.

MODEL 8. **Tray with Flaps.** (9 in. square, stiff coloured paper.)

Fold and cut out 7 in. square. Fold to obtain creases in Fig. 130.

Mark points 3 in. from each corner of the square and fold to obtain lines in Fig. 131.

The inner square forms the base of the box.

Fold corners and fix as in sketch (Fig. 132). Flaps may be placed either inside or outside.

MODEL 9. **Letterette.** (10 in. square "granite" paper.)
Fold and cut out 8 in. square.
Set out measurements and fold to obtain dotted lines (Fig. 133).
Cut out shaded portions (Fig. 134), large triangle first.
Gum edges of flap. Allow to dry before folding down.
Complete model as shown in sketches (Figs. 135 and 136).

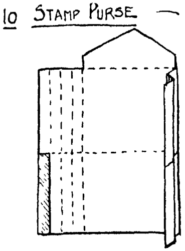


Fig. 137.

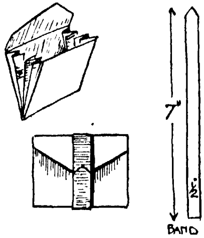


Fig. 138.

MODEL 10. **Stamp Purse.** (10 in. square coloured paper.)
Fold and cut out shape exactly as in previous model (Fig. 133).

Fold side flaps into four as shown. Arrange in position (Fig. 137).

Fold on middle line and gum sides together.

Cut a strip 7 in. by ½ in. to form a band, and fix in position (Fig. 138).

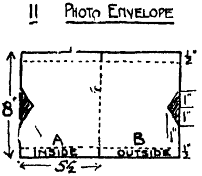


Fig. 139.

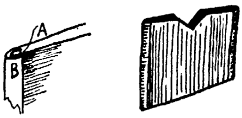


Fig. 140.

MODEL 11. **Photo Envelope.** (12 in. by 9 in., brown paper.)

Fold rectangle 11 in. by 8 in. and cut out.

Set out measurements. Fold to obtain dotted lines and cut out shaded portions (Fig. 139).

Gum edges and fix in position. Note that one flap is inside and must be gummed on the opposite side to that folded on the outside (Fig. 140).

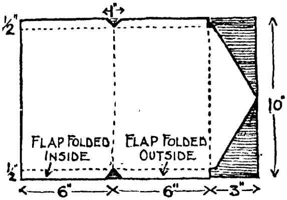


Fig. 141.

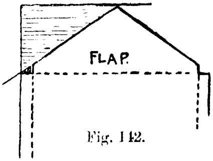


Fig. 142.

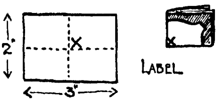


Fig. 143.

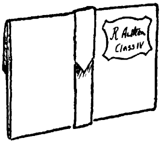


Fig. 144.

MODEL 12. **Specimen Envelope.** (16 in. by 11 in., brown paper.)

Fold and cut out rectangle 15 in. by 10 in.

Set out points to measurements shown, and fold (Fig. 141).

Cut shaded portions (Fig. 142).

Gum side flaps, one inside, the other outside, as in previous model.

Cut a strip 13 in. by 1 in. for a band and fix in position.

Cut rectangle of white paper 3 in. by 2 in. Fold as shown (Fig. 143).

Draw shape on quarter and cut out label. Gum label and fix in position (Fig. 144).

STAGE III.

Tools as in Stage II, with the addition of a Needle or a Kindergarten Pricker (Fig. 91) for scoring the lines before folding.

Material.—Brown paper, Manilla paper, and thin tinted boards.

(NOTE.—In the drawings, a dotted line indicates a folded line and a heavy line a cut line.)

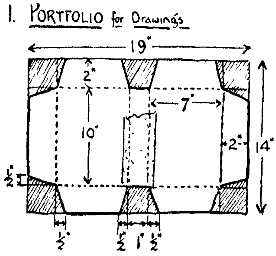


Fig. 145.

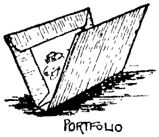


Fig. 146.

MODEL 1. **Drawing Portfolio.** (19 in. by 14 in., brown paper.)

Set out lines shown in net. Cut out shaded portions (Fig. 145).

Gum a strip of paper 10 in. by 2 in. along the middle to strengthen the back (sketch shows only a portion of the strengthening strip).

Fold side and top flaps into position (Fig. 146).

MODEL 2. **Book Marker.** (6 in. by 3 in., Manilla paper.)

Before making this model the pupil should first make a model right angle in paper. Take a piece of stout white paper about 10 in. by 6 in. Draw a straight line near one edge and cut off accurately. Fold this line in half and crease, thus forming a line at right angles to the first line. Gum the two halves together, mark the right angle and cut to the shape of a right-angled triangle (Fig. 147).

Draw rectangle 4 in. by $2\frac{1}{2}$ in., using template for right angle, instead of folding, as in previous exercises.

Set out measurements as shown in design. Cut heavy lines and score dotted lines (Fig. 148).

Fold to shape and gum smaller flap on top (Fig. 149).

Right Angle Template

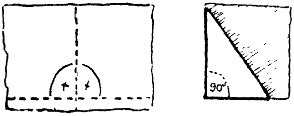


Fig. 147.

2. Book Marker

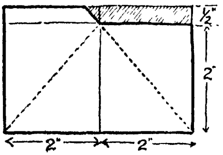
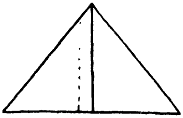


Fig. 148.



Finished Model

Fig. 149.

3 Luggage Label

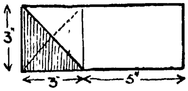


Fig. 150.

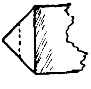


Fig. 151.

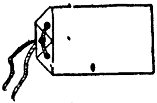


Fig. 152

MODEL 3. **Luggage Label.** (9 in. by 4 in., Manilla paper).
Draw design and cut on heavy lines (Fig. 150).
Score and fold on dotted lines as shown in Figs. 150 and 151.
Gum end down, pierce holes and fix string (Fig. 152).

MODEL 4. **Comb Case.** (6 in. by $3\frac{1}{2}$ in., Manilla paper.)
Draw design, first drawing rectangle 5 in. by $2\frac{3}{4}$ in. (Fig. 153).
Cut on heavy lines. Score and fold on dotted lines.
Fold side flaps down and gum on outside.
Make small band $\frac{3}{4}$ in. wide to keep case closed (Fig. 154).

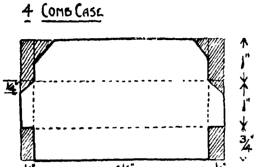


Fig. 153.

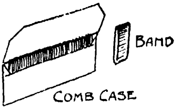


Fig. 154.

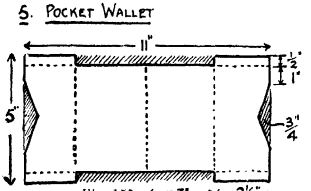


Fig. 155.

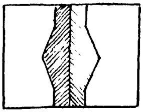


Fig. 156.

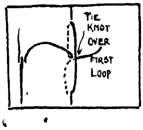


Fig. 157.

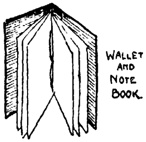


Fig. 158.

MODEL 5. **Pocket Wallet and Note Book.** (12 in. by 6 in., Manilla paper. 2 sheets white paper, 8 in. by 6 in.)

Draw rectangle 11 in. by 5 in., set out measurements and complete the design (Fig. 155).

Cut on heavy lines. Score and fold on dotted lines.

Gum flaps in position (Fig. 156).

Fold and cut sheets of paper and assemble in book form, having pages 4 in. by 3 in.

Sew through back as shown in sketch (Fig. 157).

Slip the outside leaves inside the pockets of the wallet (Fig. 158).

6. COMPASS CARD.

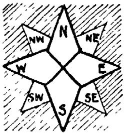


Fig 160.

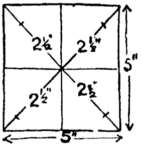


Fig. 159.

MODEL 6. **Compass Card.** (6 in. square, tinted cardboard.)

Draw 5 in. square. Draw lines shown in Fig. 159.

Mark points 2½ in. from centre along each diagonal.

Cut out star and mark points N., S., E., W., etc. (Fig. 160).

7 SILK WINDER

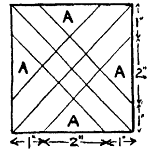


Fig. 161.

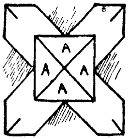


Fig. 162.

MODEL 7. **Silk Winder.** (5 in. square, tinted board.)

Draw a square of 4 in. side and complete the design.

Cut out the triangles marked *A* (Fig. 161) and fix them with gum at the centre of the figure to form an inner square (Fig. 162).

Cut corners of figure on heavy line to hold ends of silk thread.

MODEL 8. **Square Box.** (6 in. square, tinted board.)

Draw a square of 5 in. side and complete the design (Fig. 163).

Cut on heavy lines. Score and fold on dotted lines.

N.B.—The folded portions must be pressed quite flat so that no spring is left in the sides.

Gum flaps and fix on inside of box (Fig. 164).

8 SQUARE BOX

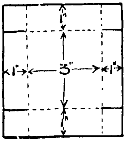


Fig. 163.

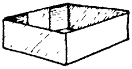


Fig. 164.

9. RECTANGULAR BOX WITH LID.

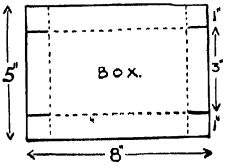


Fig. 165.

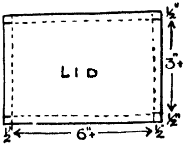


Fig. 166.

MODEL 9. **Rectangular Box with Lid.** (9 in. by 10 in., tinted board.)

Draw rectangle 8 in. by 5 in. and complete the design (Fig. 165).

Proceed as in last model.

To make the lid place the box on the cardboard and draw round with pencil, thus obtaining a rectangle slightly larger than 6 in. by 3 in.

Produce each side and mark off points ½ in. from each corner. Complete the design (Fig. 166). Proceed as in making the box.

MODEL 10. **Square Tray** with sloping sides (6 in. square, tinted board).

Draw 5 in. square and cut out.

Set out lines shown (Fig. 167).

Score dotted lines (care must be taken not to carry the scored lines past the corners of the inner square).

Cut on heavy lines and fold.

Gum flaps on under side of tray and cut off the projecting portion (Fig. 168).

10 TRAY WITH SLOPING SIDES

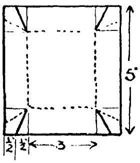


Fig. 167.

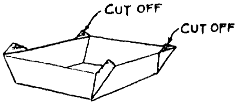


Fig. 168.

11 PEN TRAY.

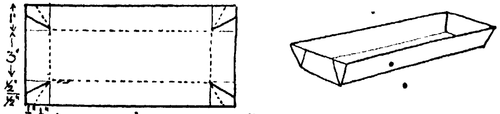


Fig. 169.

MODEL 11. **Pen Tray.** (11 in. by 6 in., tinted board.)

Set out lines of design (Fig. 169) and proceed as in previous model.

MODEL 12. **Hair Tidy.** (7 in. by 7 in., tinted board.)

Draw 6 in. square. Set out lines as shown in design (Fig. 170). Cut out square. Cut heavy lines.

Score and fold on dotted lines. Fix corners.
Bore holes and hang with cord as shown (Fig. 171).

12 HAIR TIDY

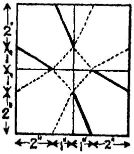


Fig. 170.

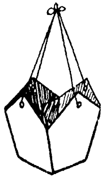


Fig. 171.

STAGE IV.

Tools as in Stage III.
Material.—Tinted boards, medium weight.

1 CUBE

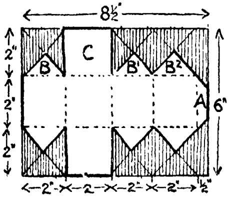


Fig. 172.

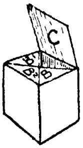


Fig. 173.

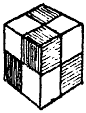


Fig. 174.

MODEL 1. **Cube.**

Set out rectangle 8½ in. by 6 in. and draw lines shown (Fig. 172).
Cut out shaded portions and score dotted lines.
Fold on dotted lines (triangular flaps inside) (Fig. 173).

(NOTE.—In fixing, first gum flap *A* and hold in position til quite firm. Proceed to gum triangular flaps *B*, *B*¹, *B*², and fi in position with square on top. These can be pressed down from inside. When set, repeat with opposite side.)

With pencil draw lines dividing each face into four squares, and shade alternate squares as shown (Fig. 174).

2 MATCH STAND

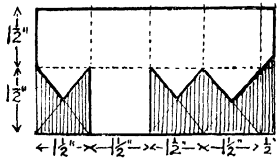


Fig. 175.

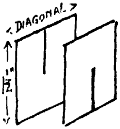


Fig. 176.

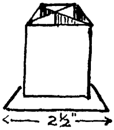


Fig. 177.

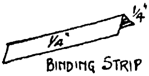


Fig. 178

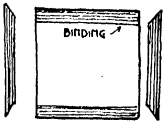


Fig. 179

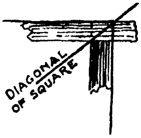


Fig. 180.

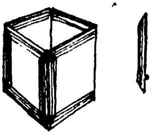


Fig 181.

MODEL 2. **Match Stand.**

Make the body of the match holder as in last exercise (Fig. 175).

Make divisions for box. Depth = 1½ in., width = diagonal of quare.

Cut each half-way up the middle and fix in position (Fig. 176).

Cut out 2½ in. square for base (Fig. 177).

Binding.—The edges are bound with strips of coloured paper ½ in. wide. The children should cut these from material supplied. Fold each strip along the middle (Fig. 178).

Binding the Square Base.

1. Bind two opposite edges of square the whole length as shown, equal portions of the binding on either side (Fig. 179).
2. Cut pieces for remaining sides and mitre the corners. (The angle may be obtained as in sketch, drawing the line freehand with a pencil before cutting.) (Fig. 180.)

Binding the Box.

1. Bind the top and bottom (with square ends) (Fig. 181).
2. Bind vertical edges (mitre top and bottom) (Fig. 181).

When complete, gum base of box and fix in position.

3 CRAYON BOX.

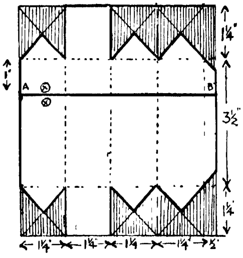


Fig. 182.

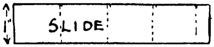


Fig. 183.

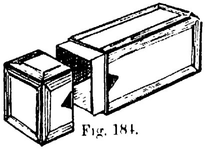


Fig. 184.

MODEL 3. **Crayon Box.** (Square Prism.)

Set out lines shown in design (Fig. 182).

Cut out shaded portions. Score and fold on dotted lines.

(N.B.—*A B* must not be cut till all the folding is finished. Place a mark on corresponding sides of top and bottom.)

Gum and fix parts in position.

Cut a slip for inside 1 in. wide, about 6 in. long. Measure inside of box and set out slide as shown. Gum the slide inside the box, ½ in. projecting (Fig. 183). Fix lid in position.

Binding.

1. Bind vertical edges whole length, square ends.
2. Bind two opposite edges of top and bottom, only one side to be mitred.
3. Bind remaining edges, both sides mitred.
4. Cut out diamond and place in position to show corresponding sides, and cut through the binding to release the lid (Fig. 184).

4 PUMP

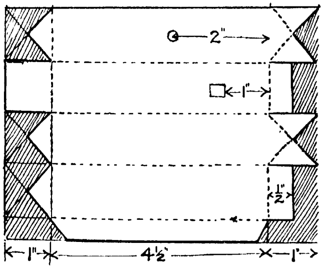
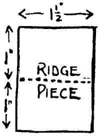
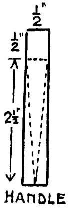


Fig. 186.





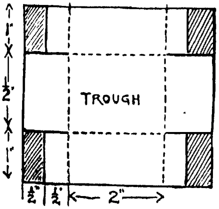


Fig. 185.

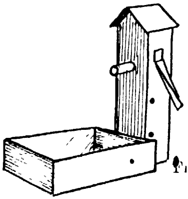


Fig 187.

MODEL 4. **Pump.**

1. Set out lines for trough (Fig. 185). Cut and fold as in previous exercises.

5. Prismatic Stand

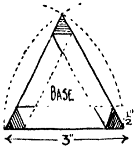


Fig. 188.

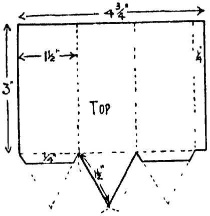


Fig. 189.

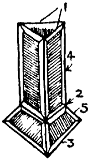


Fig. 190.

6 Dog Kennel.

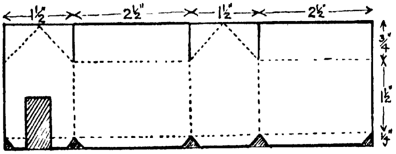


Fig. 191.

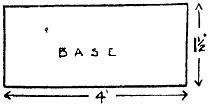


Fig. 192.

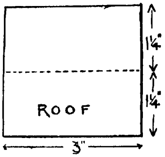
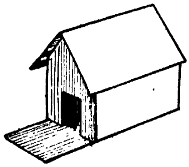


Fig. 193.



2. Set out lines for body (Fig. 186). Cut and fold. The small triangular flaps at the top must be folded in, to support the ridge piece, which is put on separately.

3. To form a spout roll a piece of cardboard round a pencil. Unroll, paste one end and re-roll. Hold till set. Make a hole in the body of the pump large enough to admit the spout. Gum end of spout and fix in hole.

4. Cut out handle, fold and fix as shown in sketch (Fig. 187).

5. Gum the body to the trough.

MODEL 5. **Prismatic Stand.**

In this exercise the arcs are drawn by means of the radius strip. Prepare a strip of cardboard, 4 in. by $\frac{1}{2}$ in., and pierce two holes 3 in. apart. With the needle through one hole marking the centre, and the sharp pencil point through the other, describe the arc. The radius strip must be kept tight whilst drawing the arc.

Set out lines for base (Fig. 188). Cut and fold as in previous exercises. Cut off projecting flaps level with sides. Set out lines for top (Fig. 189). Cut, fold, and fix the sides and base of body. When firm, paste the triangular end of the body and fix to the base.

In binding, fix strips in order shown (Fig. 190).

MODEL 6. **Dog Kennel.**

Set out the lines and proceed as in former exercises (Fig. 191). Separate pieces are to be cut for base and roof (Figs. 192, 193).

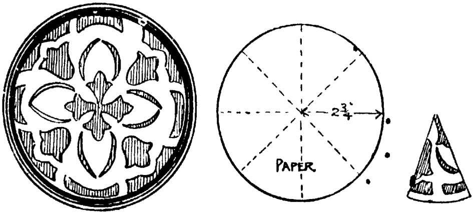
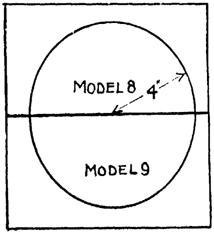


Fig. 194.

MODEL 7. **Circular Mat.**

The circle is marked out with the radius strip. This] is an exercise in cutting a curve, and care must be taken to keep the edge even and not a series of jags. Any suitable design may be cut in tinted paper. This is best done by folding the circle to obtain one-eighth part as shown (Fig. 194).



MODEL 8. **Hanging Pocket.**

Mark out circle of 4 in. radius. Cut along a diameter, one half is required for Model 8 and the other for Model 9. By means of the radius strip obtain the lines shown (Fig. 195). Score the dotted lines and fix with *A* and *B* together. Finish with cords to hang (Fig. 196).

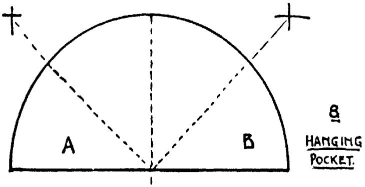


Fig. 195.

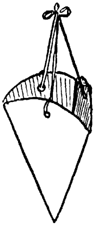


Fig. 196.

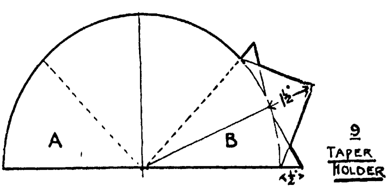


Fig. 197.

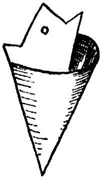


Fig. 198.

MODEL 9. **Taper Holder.**

Set out the lines and proceed as in previous exercises (Fig. 197). Flap *A* is pasted behind the model. Care must be taken to keep the round portion in front free from creases (Fig. 198).

MODEL 10. **Candle Shade. (Circular.)**

Describe circle of 4 in. radius. Cut out.

Describe inner circle of 1 in. radius. Draw two radii at right angles. Cut out the quadrant and then the inner circle. Gum a band ½ in. wide along one radius and fix in position (Fig. 199).

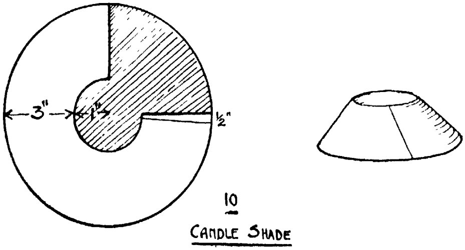
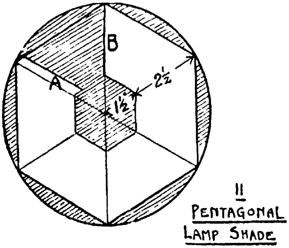


Fig. 199



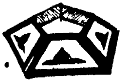


Fig. 201.

Fig. 200.

MODEL 11. **Pentagonal Lamp Shade.**

Describe circle of 4 in. radius. Obtain points for hexagon, using the radius strip with the same radius. Describe inside circle of 1½ in. radius

Cut out the shaded portions (Fig. 200).

Gum flap *A* on under side of *B*.

The sides of the shade may be decorated with simple designs cut out in paper and pasted on (Fig. 201).

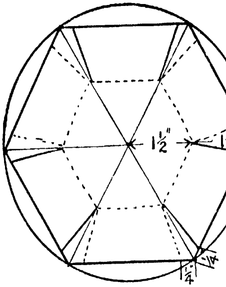


Fig. 202.

12 HEXAGONAL TRAY

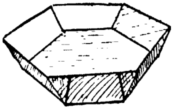


Fig. 203.

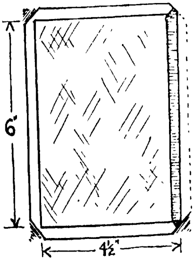


Fig. 204.

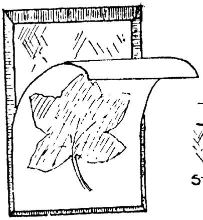


Fig. 205.

MOUNT

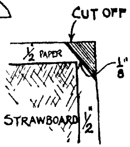


Fig. 206.

CORNER

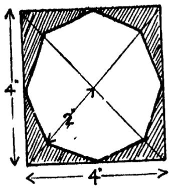


Fig. 207.

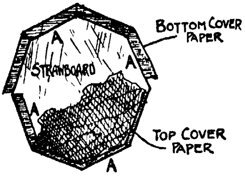


Fig. 208.

2 OCTAGONAL MAT.

MODEL 12. **Hexagonal Tray. (Sloping Sides.)**

Describe circle of 3 in. radius. Inscribe a hexagon as in previous model. Describe inner circle of $1\frac{1}{2}$ in. radius. Mark points $\frac{1}{4}$ in. from each corner of the hexagon (Fig. 202).

Cut out and fold on dotted lines.

Gum flaps on under side of tray and cut off projecting portions (Fig. 203).

STAGE V.

Material.—White pulpboard or yellow strawboard of medium thickness.

Fancy covering papers.

Bookbinders' cloth and calico for binding.

Paste.

Tools.—Cardboard modelling knife (Fig. 93).

Straight-edge (Fig. 96).

Cutting slab not smaller than 12 in. by 10 in.

Pair of scissors, 5 in. or 6 in. long.

Bone folder.

MODEL 1. **Simple Mount.**

Cut out a piece of strawboard 6 in. by $4\frac{1}{2}$ in., tinted paper, 7 in. by $5\frac{1}{2}$ in., white paper, $5\frac{3}{4}$ in. by $4\frac{1}{4}$ in.

Paste the tinted paper all over, particularly the edges, and place strawboard in position with equal margin all round (Fig. 204).

Cut off corners of paper to within $\frac{1}{8}$ in. of corner of strawboard (Fig. 206).

Fold long edges first, pulling the paper tightly against the edge of the strawboard. Fold over short edges and press down with folder. Square the edges with the folder.

Paste the piece of white paper and place in position with equal margin all round (Fig. 205).

Mount a pressed dry leaf on the white paper.

MODEL 2. **Octagonal Mat.**

Cut out 4 in. square of strawboard. Draw diagonals and mark off points 2 in. from centre. Complete octagon and cut out (Fig. 207).

Lay octagon on piece of covering paper and mark out a larger octagon with sides parallel to first octagon and $\frac{1}{2}$ in. away.

Paste paper all over (particularly the edges). Place strawboard in position and fold over edges marked *A* (Fig. 208)

Fold over remaining edges, press down corners with folder.

Cut octagon of fancy paper to show margin of $\frac{1}{16}$ in. all round.

Paste and mount in position.

MODEL 3. **Calendar** (Fig. 210).

Cut out octagon from 6 in. square as in sketch, using radius strip for arcs. Radius equal to half the diagonal (Fig. 210).

Cover as Model 2.

Cut slots as shown in Fig. 209.

Cut strips and mark on days, months and figures. The strips may be made either of Manilla paper, or of binding linen, and are passed through the slots as shown in section, loose ends hanging at the back (Fig. 211).

MODEL 4. **Money Box** (Fig. 214).

Set out lines shown in drawing (Fig. 212).

Cut out heavy lines and half cut the dotted lines.

Fold and crease the sides (with half cut on the outside of the fold).

N.B.—The sides should be folded down flat with the folder. Any spring left in the folded sides tends to spoil the shape of the model.

Bind the edges with strips of white calico, 1 in. wide, folded down the middle. It is not necessary to mitre the corners, but care should be taken not to get a double thickness at the corners as this shows on the finished model.

Cut a piece of fancy paper, $8\frac{1}{4}$ in. by 3 in. Paste and fix as shown (Fig. 213).

Cut a notch at the corners and fold ends down (Fig. 213).

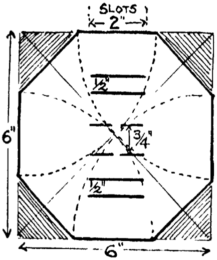
Cut square pieces and fit on ends.

Cut through the paper covering the slot, and press neatly round the edges with the folder.

MODEL 5. **Square Tray** (Fig. 218).

Cut out design. Half cut and fold the sides (Fig. 215).

Bind corners as shown (Fig. 216) with strips of calico 1 in. wide, $1\frac{1}{2}$ in. long. Notch the tops of the calico strips and fold



3. CALENDAR.

Fig. 209.

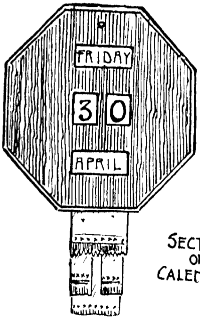


Fig. 210.

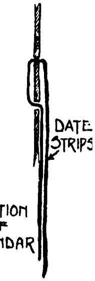
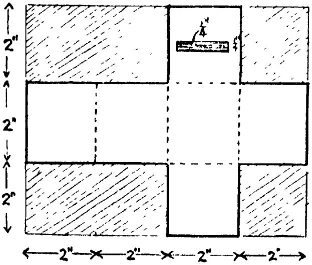


Fig. 211.



4. MONEY BOX.

Fig. 212.

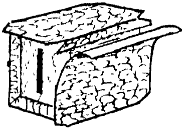


Fig. 213.

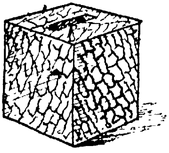


Fig. 214.

the ends inside. Cover the sides with fancy paper. This is best done in two operations, one piece 6½ in. by 2 in., the other 6 in. by 2 in., the last piece covering from corner to corner, the first piece overlapping the corner (Fig. 217).

Cover the base with 3 in. square.

Line the bottom of the inside with a square filling the bottom fully, *i.e.* slightly larger than 3 in. Line the sides (in two operations) with strips ¾ in. wide as in covering the outside.

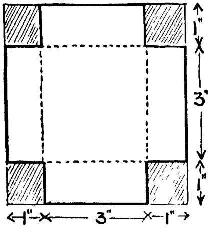


Fig. 215.

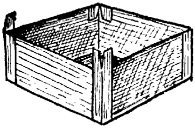


Fig. 216.

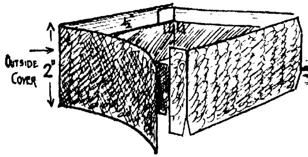


Fig. 217.

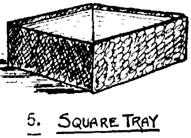


Fig. 218.

MODEL 6. **Box with Lid.**

Make lower portion as in Model 5, with measurements to suit (Fig. 219).

Make lid in the same manner, allowing $\frac{1}{16}$ in. all round over size of box. Cover as in Model 5.

MODEL 7. **Match Holder.** (Fig. 222.)

Cut out design for back and for box (Figs. 220 and 221).

Bind front edges of box.

Cover the box as in previous exercise, folding the top edges inside the box.

Cover the back piece. Fold over the long edges first, next the ends, and lastly the corners. There is no need to cut off the corners as in Model 1.

Gum the box in position on the back piece. Punch hole, and fix piece of glasspaper on front (Fig. 222).

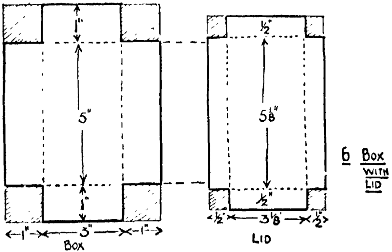


Fig. 219.

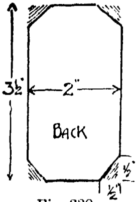


Fig. 220.

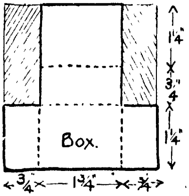


Fig. 221.

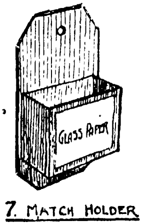


Fig. 222.

MODEL 8. **Pencil Case.**

Draw development (Fig. 223), and proceed as in previous exercises.

Cut pieces for partitions and fix at ends with angle pieces of linen (Fig. 224).

Cover outside as in Model 5. Make cuts where the sides fold on the partitions.

Cover each partition separately with a single piece (*see* section) (Fig. 225). Finish as in previous exercises.

Measurements for the slide must be made from the box itself.

Cover the inside before folding, and do not crease till dry.

Bind the two edges of slide together with linen strip.

Bind the ends with strips of leather cloth ½ in. wide (¼ in. inside, ¼ in. outside), the two long strips slightly longer than the width of the slide, the two small strips exact depth of slide.

Cover outside of slide with one piece of paper, leaving ⅛ in. of binding showing at each end (Fig. 226).

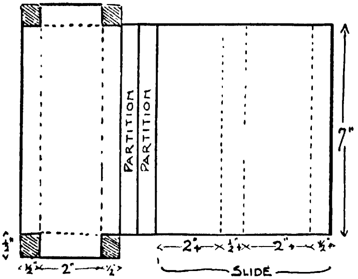


Fig. 223.

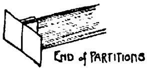


Fig. 224.

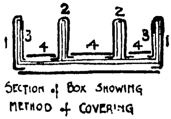


Fig. 225.

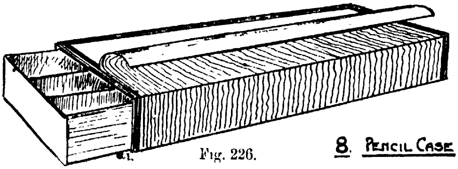


Fig. 226.

MODEL 9. **Hexagonal Spill Holder.**

Cover one side of strawboard with suitable inside covering paper, and on opposite side draw development (Fig. 227).

Cut out, and, when paper is quite dry, fold to shape.

Bind long edge of hexagonal prism with linen.
Bind top with fancy cloth as in Model 8.
Cover sides with fancy paper.
Cut out hexagon for base (Fig. 228) and cover as in Model 2.
Fix top in position on base (Fig. 229).

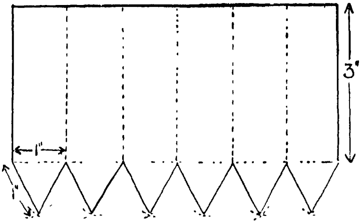


Fig. 227.

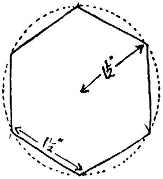


Fig. 228.

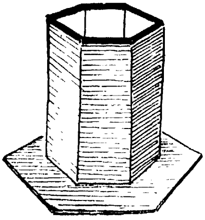


Fig. 229.

9 Hexagonal Spill Holder.

MODEL 10. **Blotting Pad.**

Cut out rectangle of strawboard 12 in. by 10 in. and cover with paper 13 in. by 11 in., folding ½ in. over edges all round (Fig. 230).

Cut out 5 in. square of cloth and cover the back with paper to stiffen it. Cut along diagonals, making four triangles.

Fold over the long side of each triangle ¼ in. and gum down.

Fix corners as shown in sketch (Fig. 230) Paste on back only, leaving front free for blotting paper.

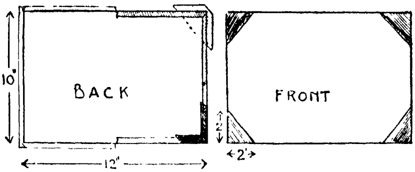
Cover the back of the pad with suitable paper, leaving margin of ⅛ in.

MODEL 11. **Jotter Case.**

Cut two pieces of strawboard, 6 in. by 3½ in. (Fig. 231).

Cut two pieces of cloth, 4½ in. by 1½ in., and 3¼ in. by 1½ in.

Hinge the two pieces of strawboard as shown, using larger strip on outside, and folding ½ in. inside at each end. Leave ½ in. between the boards (Fig. 232).



10 Blotting Pad.

Fig. 230.

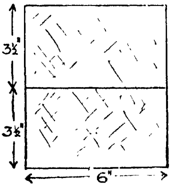


Fig. 231.

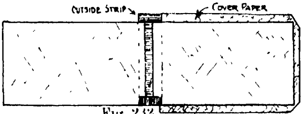
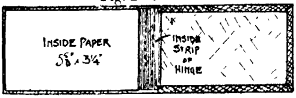


Fig. 232.



11. Jotter Case. Fig. 233.

Place smaller piece of cloth inside as shown (Fig. 233).

Cut two pieces of covering paper 6¼ in. by 4½ in. and cover the outsides of case as shown (Fig. 232).

Line the inside with white paper, showing margin of ⅛ in. (Fig. 233).

Cut a piece of elastic to hold jotter in case.

MODEL 12. **Folding Draughtboard.**

Cut two pieces strawboard 11 in. by 5½ in.

Make a close hinge just sufficient for the boards to close (Fig. 234).

Cut 3 in. square of cloth, cut along diagonals, and fix on corners as shown (Figs. 234 and 235). Paste cloth all over.

Cover outside, cutting cover papers to shape shown (Fig. 234).

Cover inside with white paper and draw squares.

Paint in the dark squares with a brush, or else cut squares of dark paper and paste in position (Fig. 236).

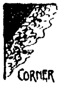


Fig. 235.

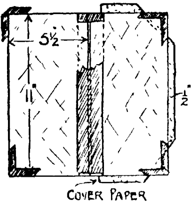


Fig. 234.

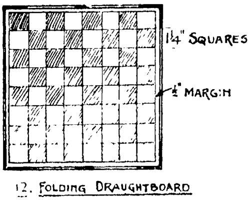


Fig. 236.

STAGE VI.

Materials and tools as in Stage V.

Heavier strawboard should be used for the larger models.

MODEL 1. **Pocket Wallet.**

Cut out two pieces of strawboard 5½ in. by 3½ in. (Fig. 237).

Cut strips of cloth, 6½ in. by 2¼ in. and 5¼ in. by 2¼ in., and make hinge as in Stage V., Model 11.

Cover outside and inside with fancy paper.

Cut two pieces of strawboard, each 5¼ in. by 3 in., for inside pockets. Cut out thumb hole. Cover one side with paper.

Hinge each piece in position with strip of cloth 5¼ in. by 1 in., as in Figs. 239 and 241.

For sides of pocket take cloth 3½ in. by 2 in. Fold ½ in. down at top end. Arrange in folds (Fig. 238) and fix as in sketch (Figs. 240, 241).

Cover remaining sides of pockets with fancy paper.

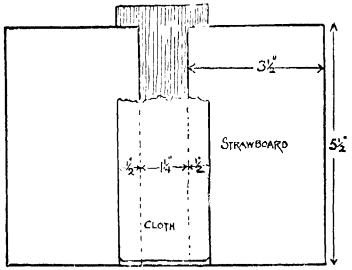


Fig. 237.

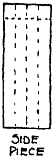


Fig. 238.

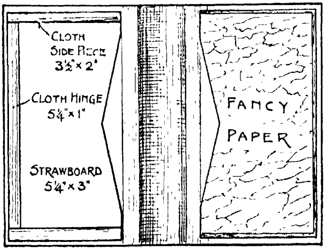


Fig. 239.

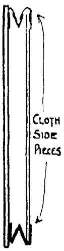


Fig. 240.

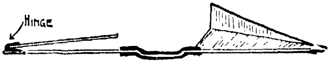


Fig. 241.

MODEL 2. **Writing Case** (Fig. 245).

Cut out strawboard to sizes shown. Make hinges as in previous exercises (Fig. 242).

Cover outside and fix tapes for fastening. Line pieces *A*, *C* inside (Fig. 242).

Make blotting pad and fix on *B* (Fig. 244).

Make pocket and fix on *A*.

Penholder is made as shown in Fig. 243, and is fixed under blotting pad.

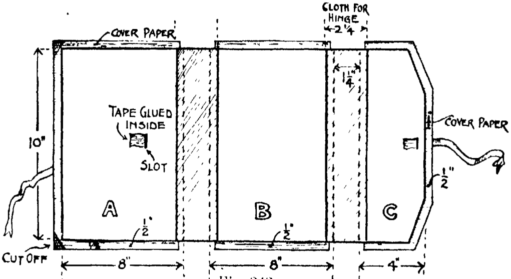
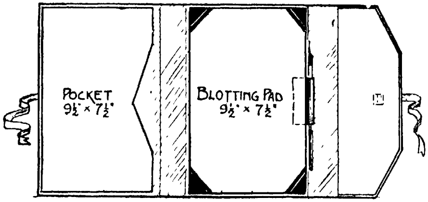


Fig. 242.



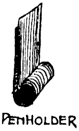


Fig. 243.

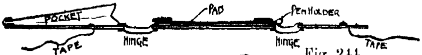


Fig. 244.

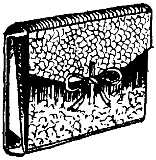


Fig. 245.

WRITING CASE

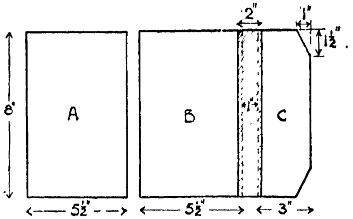


Fig. 246.

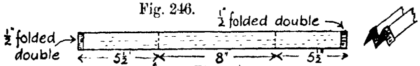


Fig. 217.

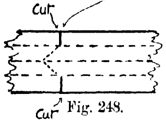


Fig. 248.

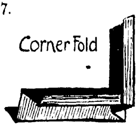


Fig. 249.

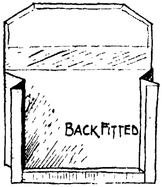


Fig. 250.

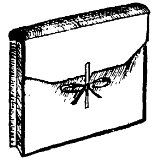


Fig. 251.

MODEL 3. **Letter Portfolio** (Fig. 251).

Cut out strawboard to sizes shown. Hinge pieces *B* and *C* with 1 in. between the pieces (Fig. 246).

Cover the inside of *A* and *B*.

Cut strip of cloth 20 in. by 2 in. Mark off and arrange folds as shown in Fig. 247.

Make small incisions shown in Fig. 248, and arrange corner folds as shown in Fig. 249.

Fix back and front inside the outer folds. Glue in position (Fig. 250).

Fix tapes and cover with fancy paper.

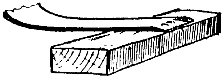


Fig. 252.

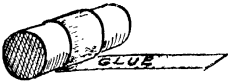


Fig. 253

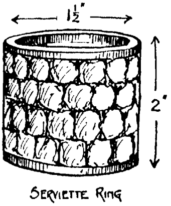


Fig. 254.

MODEL 4. **Serviette Ring** (Fig. 254).

Cut strip of thin cardboard 24 in. by 2 in.

Thin off each end on opposite sides with a file or knife. To do this place the end of the strip on a piece of board at the edge (Fig. 252).

Glue the strip after rolling portion on the roller, which should have a diameter of 1½ in. (Fig. 253). The joining, if properly tapered, should hardly be perceptible.

Bind the ends with a strip of cloth 5 in. by ½ in.

Cover inside with lining paper and outside with fancy paper.

MODEL 5. **Round Paint-brush Case** (Fig. 256).

Make slide first. Cut piece of thin cardboard 19 in. by 8 in.

Cover about 4 in. with lining paper. This is placed inside, and will save lining when the cardboard is rolled.

Wind on a roller, 1 in. diameter, first tapering ends as in Model 4.

For box, cut out a piece of thin cardboard, 20 in. by 8½ in.

Taper ends, and wind over the top of the slide.

Cut off portion for lid 2½ in. from end. A line should first be marked—using a piece of paper wrapped round the model as a guide. Cut with a knife on the roller.

Bind the cut ends with a strip of cloth as in Model 4.

Line inside of lid and the portion of slide (about 2½ in. from end) which is exposed when in position.

Cut two circles of thick cardboard 1 in. diameter and two larger circles equal to diameter of box.

Glue the two circles together (large and small) and glue on ends of box (Fig. 255).

Bind ends with cloth.

Cover sides and ends with suitable paper.

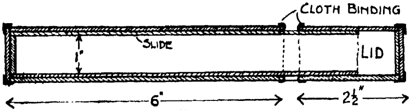
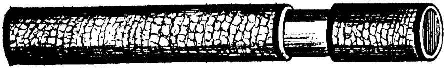


Fig 255.



PAINT BRUSH BOX. Fig. 256.

MODEL 6. **Picture Frame.** (Passé Partout) (Fig. 258).

Obtain a picture postcard and mount on a suitable mount 8 in. by 5½ in.

Obtain a piece of picture glass, same size as the mount. File off the sharp edges and corners.

Cut piece of stout cardboard same size as mount.

In strawboard cut slots, and fix rings with tapes glued on inside (Fig. 257). (Special rings with metal clips may be had for the purpose.)

Cut two strips of cloth 8 in. by 1 in. and two 5½ in. by 1 in.

Mark pencil line ¼ in. from edge of cloth strip and glue in position round the glass (Fig. 257). Mitre the corners.

When set, place the picture in position (be sure the glass is clean on the inside) together with the strawboard back piece, glue the cloth strips and fold round the back.

Cover the back with suitable paper, cutting slots for the rings to pass through.

MODEL 7. **Photo Frame.**

On piece of stout strawboard 7 in. by 5 in. set out lines shown in Fig. 259, and cut to outline.

Bind outside and inside edges with strips of cloth ½ in. wide.

Make pocket to hold photo, one piece 3¾ in. square, four pieces 3¾ in. by ¼ in., two pieces 3¼ in. by ¼ in. Glue the 3¾ in. strips to sides—smaller strips at bottom.

Bind edges with cloth, and glue pocket in position (Fig. 260).

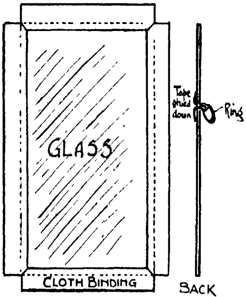


Fig. 257.

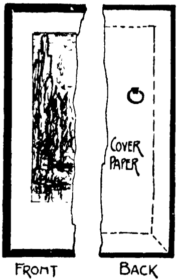


Fig. 258

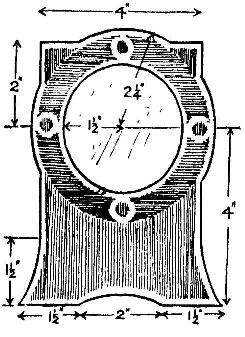


Fig. 259.

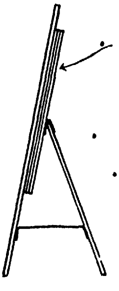


Fig. 260.

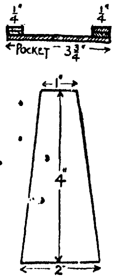


Fig. 261.

Cut out piece of strawboard for strut (Fig. 261). Cover with paper.

Cover the back of the photo frame with suitable paper and hinge strut in position (Fig. 260).

Cover the front of the frame with fancy paper as shown in design.

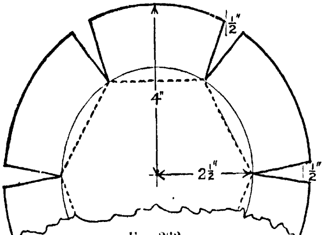


Fig 262.

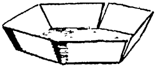


Fig. 263.

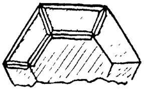


Fig. 264.

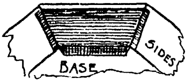


Fig. 265.

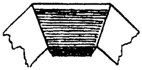


Fig. 266.

MODEL 8. **Hexagonal Tray.**

Set out lines shown (Fig. 262).

Cut out heavy lines and half cut dotted lines.

Fold on dotted lines to form hexagonal tray.

Bind joints with pieces of cloth 1 in. wide. Fix on under side of tray and cut level with top (Fig. 263).

Fit pieces of silver paper, $\frac{1}{2}$ in. wide, round each panel. Mitre the corners (Fig. 264).

Fit each panel with a piece of coloured paper, leaving margin of $\frac{1}{8}$ in. all round.

Hexagon for base inscribed in circle of $2\frac{3}{8}$ in. radius.

Cover alternate panels of outside as shown in Fig. 265.

Remaining panels fitted as in Fig. 266.

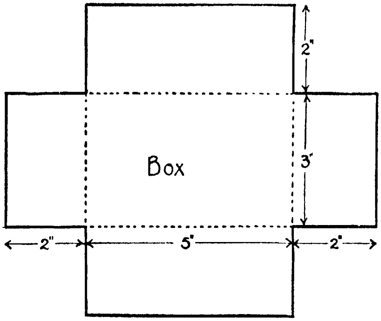


Fig 267.

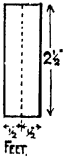


Fig. 268.

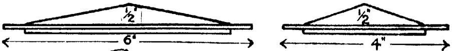


Fig. 269.

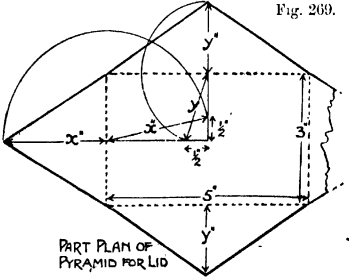
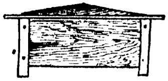


Fig. 270.



TRINKET BOX

MODEL 9. **Trinket Box.**

Set out lines for various parts (Fig. 267).
Cut out heavy lines. Half cut dotted lines.
Bind corners of box with strips of cloth 1 in. wide.
Cover outside of box with Japanese veneer paper. Cover long

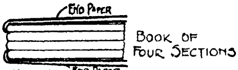


Fig. 271.

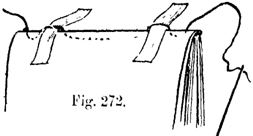


Fig. 272.

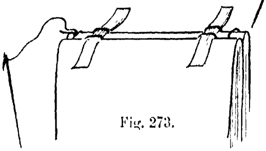


Fig. 273.

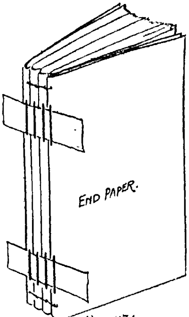


Fig. 274.

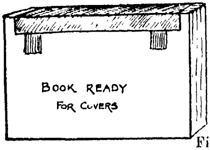


Fig. 275.

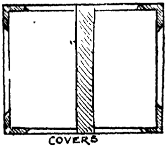


Fig. 276.

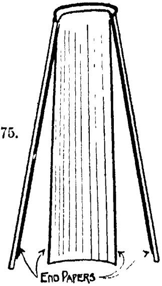


Fig. 277.

sides first, overlapping top, sides, and base $\frac{1}{2}$ in. Cover ends with paper fitting to sides—overlapping top and base $\frac{1}{2}$ in. Cover the base with piece $4\frac{7}{8}$ in. by $2\frac{7}{8}$ in.

Cover feet (Fig. 268) with gold tinsel paper and glue in position.

Line the inside, long sides first, then ends, then base.

Build up lid as shown in Figs. 269 and 270, lowest piece to fit inside top of box. Each part should be covered separately before glueing together.

Pyramid covered with veneer paper, remainder of lid covered with gold tinsel paper. Inside portion covered with lining paper.

MODEL 10. **Simple exercise in Book-binding.**

Select a book with small number of sections.

Take the book down (*i.e.* pull it to pieces) remove all unnecessary matter (backs, advertisements, etc.).

Cut two pieces of linen tape 1 in. wide—length equal to thickness of book plus 2 in.

Cut pieces of lining paper, fold to form *end papers*, and place at beginning and end of outside sections as in Fig. 271.

Sew on tapes to first section as shown in Fig. 272.

Continue the sewing with second section as in Fig. 273.

At the end of section two tie the thread to the beginning of section one.

Continue with the remaining sections knotting each section to the previous section (Fig. 274).

When finished, glue on a strip of cloth as in Fig. 275. The book is then ready for the covers.

Prepare covers with cloth hinge and cover with fancy paper on outside (Fig. 276).

Glue book in the covers, taking care to have end papers in correct position (Fig. 277).

SUPPLEMENTARY MODELS.

Cardboard Modelling may be made very useful in the teaching of science, and the following exercises are intended as suggestions of correlation with Mathematics, Mechanics, and Physics.

MODEL 1. Fig. 278. Comparison of English and Metric measurements of length.

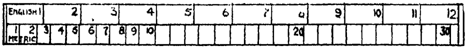


Fig. 278

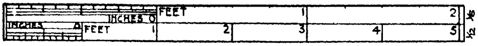


Fig. 279

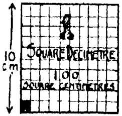


Fig. 280.

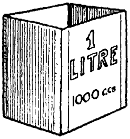


Fig. 281.

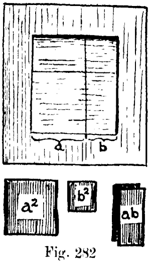


Fig. 282

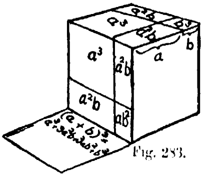


Fig. 283.

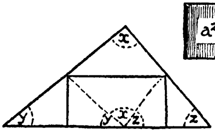


Fig. 284.

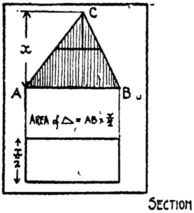


Fig. 285.

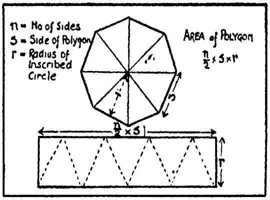


Fig. 286.

Model 2. Fig. 279. Draughtsman's Scale, showing scales $\frac{1}{12}$ and $\frac{1}{6}$.

Model 3. Fig. 280. Model of one square decimetre.

Model 4. Fig. 281. Model of one cubic decimetre (1 litre).

Model 5. Fig. 282. Model illustrating $(a + b)^2$.

Model 6. Fig. 283. Model illustrating $(a + b)^3$.

Model 7. Fig. 284. The corners fold over with a cloth hinge, showing the interior angles of the triangle equal to two right angles.

Model 8. Fig. 285. Area of a triangle. The triangle may be lifted out and rearranged in the lower recess to form a rectangle. The triangle and rectangle are first cut out in a piece of cardboard. This piece is then glued to a back piece.

Model 9. Fig. 286. Area of a polygon, similar to Model 8.

Model 10. Fig. 287. Area of a circle.

Model 11. Fig. 288. Model illustrating the square on the hypotenuse of a right-angled triangle. As in Model 8, the parts of the two small squares can be lifted out and fitted in the larger square.

Model 12. Fig. 289. Cube divided into three congruent pyramids. The three pyramids fit together into the hollow cube. The net of the pyramid is shown.

Model 13. Fig. 290. Simple theodolite for obtaining angles of elevation and depression.

Model 14. Fig. 291. Model illustrating intersection of planes.

Model 15. Fig. 292. Model illustrating the projections of a line inclined to VP and HP. The line is represented by a piece of black thread.

Model 16. Fig. 293. Model to illustrate the section of a cube shown in plan and elevation.

Model 17. Fig. 294. Centre of Gravity by experiment.

Model 18. Fig. 295. Model illustrating the Principle of Moments. When experimenting the model is suspended by the loop at the top.

Model 19. Fig. 296. Pulleys. The discs may be cut out with a disc cutter.

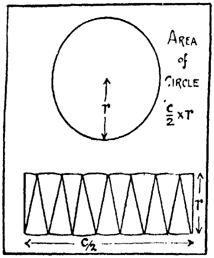


Fig. 287.

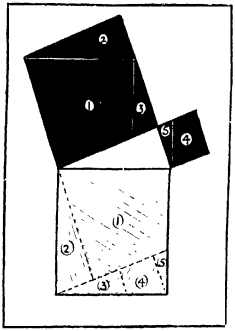
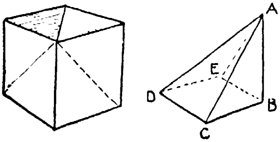


Fig. 288.



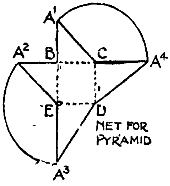
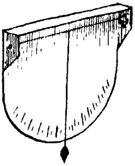


Fig. 289.



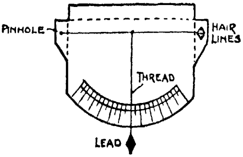


Fig. 290.

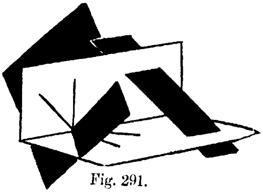


Fig. 291.

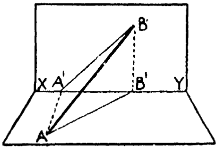
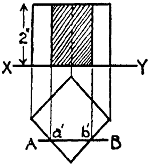


Fig. 292.



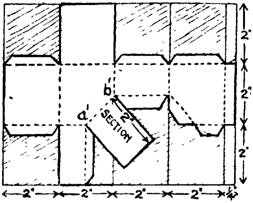


Fig. 293.

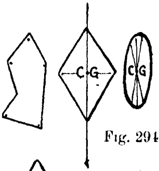


Fig. 294.

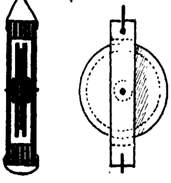


Fig. 296

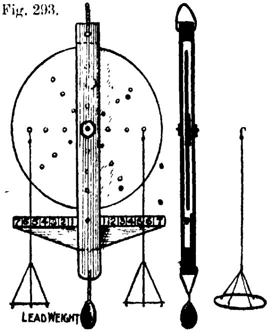


Fig. 295.

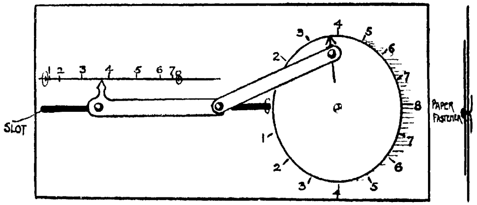


Fig. 297.

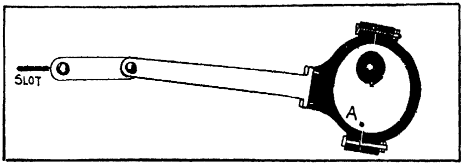


Fig 298.

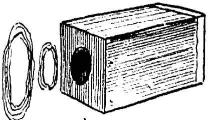


Fig. 299.

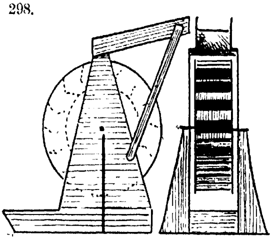


Fig. 300.

Model 20. Fig. 297. Change of motion. The moving parts are held by paper fasteners.

Model 21. Fig. 298. Eccentric motion. The sheave is rotated by placing a pencil point in hole at A.

Model 22. Fig. 299. Vortex ring box. The end opposite the hole is covered with parchment.

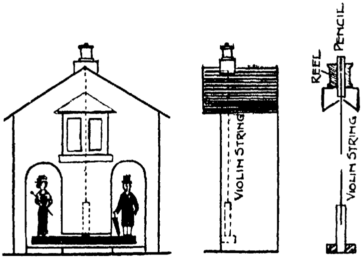


Fig. 301.

Model 23. Fig. 300. Model of an overshot water-wheel. Silver sand is used to work the model.

Model 24. Fig. 301. Hygroscope. The figures are mounted on a small bar of wood which is fitted with a round plug in the middle. These are suspended on a piece of violin string which hangs from the chimney. The top of the chimney consists of a cotton reel with a hollow lead pencil passing through the hole. The end of the violin string is glued in the groove of the pencil which may be twisted in the hole of the reel in making adjustments.

DIRECTOR OF INDUSTRIES
Bengal

CHAPTER VII.

WOODWORK.

EQUIPMENT.

The **Workshop** should be rectangular, and for a class of 20 boys a room of 35 ft. by 25 ft. inside will be found suitable. There should be sufficient floor space to give freedom of movement round each bench. Long narrow rooms with wall benches should be avoided, as this arrangement prevents the teacher from having an uninterrupted view of each pupil at work. Wood blocks make a suitable floor and make a firm stand for the benches.

The **Lighting** of the workshop is very important. The room should be lit from three sides—the windows running as high as possible.

Benches.—The best form of bench is the dual bench 5 ft. 6 in. by 2 ft. 9 in., and standing 30 in. or 31 in. high. These should be arranged so that the pupil gets a good light on his work, and so that the teacher can see each pupil at work from any point in the room. Fig. 302 shows a good form of bench fitted with cupboards and tool racks at each end.

The *Racks* hold all the general tools for two pupils, and may be reversed and locked in position so that the tools are inside the cupboard. The tools are easily reached from the working position, and do not interfere with the accommodation of the bench in any way. Racks placed on the top of the bench are undesirable, as they restrict the working space and intercept the view of the teacher. Floor racks take up space and make the cleaning of the room more difficult. Wall racks for auxiliary tools are quite satisfactory, but for general tools it either means that there is

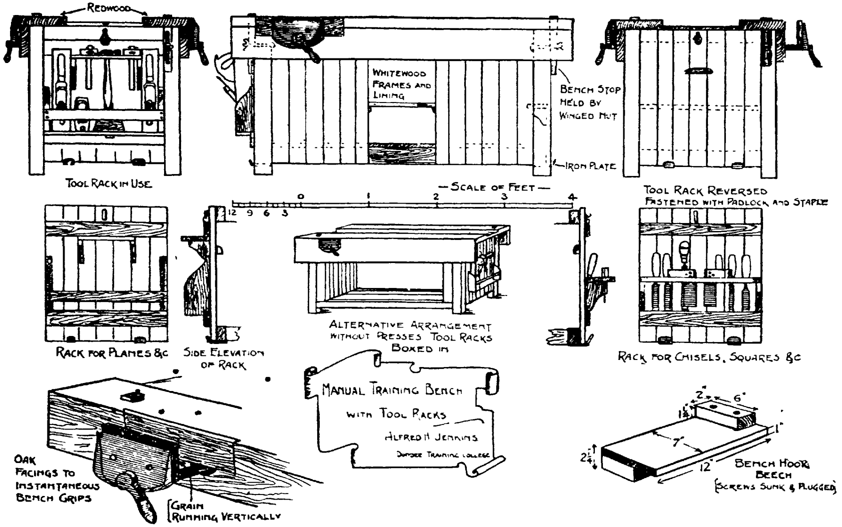

Redwood
Tool Rack in Use
Whitewood Frames and Lining
Bench Stop Held by Winged Nut
Iron Plate
Tool Rack Reversed Fastened with Padlock and Staple
— Scale of Feet —
12 9 6 3 0 1 2 3 4
Rack for Planes &c
Side Elevation of Rack
Alternative Arrangement without Presses Tool Racks Boxed in
Rack for Chisels, Squares &c
Manual Training Bench
with Tool Racks
Alfred H Jennins
Dundee Training College
Oak Facings to Instantaneous Bench Grips
Grain Running Vertically
2"
6"
1½"
7"
1"
2¼"
12"
Bench Hook
Beech
(Screws Sunk & Plugged)

Fig. 302.

too much travelling backwards and forwards, or the whole of the tools lie on the top of the bench during work.

The *Bench Stop* is adjustable, and is held firmly in position by a winged nut under the end of the bench.

A *Bench Hook* made of hard wood should be provided for each bench, to facilitate sawing, and to save the top of the bench, Fig. 302.

Tools.—Care should be taken to select tools of suitable size, as the ordinary joiner's tools are generally too big for pupils of 12 to 14 years of age.

The following list of tools (costing altogether about £50) will be necessary for a class of 20 pupils, and as the need arises new tools may be added. The teacher should be consulted in the selection of the tools, as many times tools are bought in the initial equipment of a workshop which are very rarely used, whilst more necessary tools are omitted.

Allocation of Tools.	Tool and Size.	Total Number required.	Approximate cost, each.		
			£	s.	d.
For every two boys	1 Bench with two inst. grip vices ...	10	2	15	0
	2 Bench Hooks (hardwood)	20	0	0	9
	1 Mallet (square mortised)	10	0	1	2
	1 Hammer (thin wide pene)	10	0	1	6
	1 Smoothing Plane (1¾ in. iron) ...	10	0	3	0
	2 Jack Planes, 14 in. by 1¾ in. ...	20	0	4	2
	2 Marking Gauges (beech)	20	0	0	4
	2 Marking Knives (cardbd. modg.) ...	20	0	0	4½
	2 Tenon Saws, 10 in. (iron backs) ...	20	0	3	0
	2 Try-Squares, 6 in.	20	0	1	0
	2 Paring Chisels, 1 in.	20	0	0	10
	1 Firmer Chisel, ¾ in.	10	0	0	7
	2 ,, Chisels, ½ in.	20	0	0	6
	1 ,, Chisel, ⅜ in.	10	0	0	5
	1 ,, ,, ¼ in.	10	0	0	5
	2 Sloyd Knives	20	0	1	0
	2 Brass Rules	20	0	0	8
For every four boys	1 Spokeshave (Beech)	5	0	0	9
	1 Cross Cut Saw, 24 in., 8 teeth ...	5	0	3	10
	1 Half Rip...	5	0	4	0

Allocation of Tools.	Tool and Size.	Total Number required.	Approximate cost, each.
For every six boys	1 Bow Saw, 10 in.	4	0 3 6
	1 Brace, 8 in. sweep	4	0 3 0
	1 Gouge, $\frac{7}{8}$ in. inside, sweep C	4	0 0 $8\frac{1}{2}$
	1 ,, ,, outside, ,, ,,	4	0 0 $7\frac{1}{2}$
	1 ,, $\frac{5}{8}$ in. inside, ,, E	4	0 0 7
	1 ,, ,, outside, ,, ,,	4	0 0 6
	1 ,, $\frac{3}{8}$ in. inside, ,, ,,	4	0 0 6
	1 ,, ,, outside, ,, ,,	4	0 0 5
	4 Sets Centre Bits ($\frac{3}{8}$ in., $\frac{1}{2}$ in., $\frac{5}{8}$ in., $\frac{3}{4}$ in., $\frac{7}{8}$ in., 1 in.)	4 Sets	0 2 3 per set
	1 Countersunk Bit	4	0 0 $4\frac{1}{2}$
	4 Sets Pin Bits, $\frac{1}{8}$ in., $\frac{3}{16}$ in., $\frac{1}{4}$ in.	4 Sets	0 0 $10\frac{1}{2}$ per set
For every ten boys	1 Bevel Stock (Rosewood)	2	0 1 11
	1 Try-Square, 12 in.	2	0 2 3
	1 Pad Saw	2	0 0 10
	1 Cutting Gauge	2	0 0 9
	1 Pincers	2	0 0 9
	1 Set Screwdrivers, 3 sizes	2 Sets	0 2 0 per set
	1 Trying Plane, 20 in. (2 in. iron)	2	0 5 6
Auxiliary Tools.	1 Oilstone, Washita (coarse)	1	0 2 9
	1 ,, ,, (fine)	1	0 2 9
	1 Set Oilstone Slips	1 Set	0 2 4
	1 Oil Can	1	0 0 6
	1 Glue Pot and Brush	1	0 2 4
	1 Pair Roundnosed Pliers	1	0 1 0
	1 Pair Flatnosed Pliers	1	0 1 0
	10 Special Bits	10	0 0 5
	1 Rebating Plane, 1 in.	1	0 2 4
	1 Carborundum Grindstone, No. 3	1	1 3 0
	1 Pair Handscrews	2	0 0 10

All the bench tools should be numbered to correspond to the bench, and a place provided for each. The general service tools should be placed in racks and numbered, with a number on the rack to correspond. If the rack is labelled with the name and size of the tool, it assists the pupil in learning the name of the tool and helps to keep each tool in its proper place.

Each pupil should have a definite place to work at, and should be held responsible for the tools on his bench. A monitor for each class should be appointed to report on the general service tools at the end of each lesson.

Cupboards should be supplied for the storage of finished and unfinished work. Where the floor space is limited, the cupboard at the end of the bench illustrated in Fig. 302 will serve the purpose. A handy method is to have a deep tray to contain the unfinished work of each class. This is placed out at the beginning of each lesson, and as each model is finished it is marked and entered and put away in the finished work cupboard. This saves a lot of time at the beginning of each lesson in the distribution of the work.

Wood Store.—In Manual Training Centres where there is a succession of classes all working to a more or less definite scheme, a great deal of time is saved in having the wood sawn out to suitable sizes for each model. Provision can be made in the course of models for the exercise of "ripping." The wood store would consist of a number of shelves, on which is stacked each separate size of wood, numbered according to the model for which it is intended. This is convenient for distribution, saves storage accommodation, and gives facility in renewing and checking stock.

For small classes with a diversity of work, the wood is best obtained in boards. These should be stacked vertically in racks in a dry room or in a corner of the workshop.

Waste wood should all be kept in a box for the purpose, as much of it will be found useful for small models.

GENERAL METHOD.

The teacher of woodwork should always keep before him the aim of Educational Handwork. The question is not "How quickly can a model be made?" but "How far can a model and the making of it be used as a means of educating the pupil?"

Before making a model, the teacher should discuss its use and shape with the children. The measurements of the model should be asked for, and then verified by use of a rule. In the earlier and simpler models of the course there is not much scope for modification, but in the later exercises the pupils will be able to suggest alternative designs and modifications which will help to develop their inventive ability. Occasionally the teacher might suggest the model and its particular use, and ask the pupils to design one to meet the requirements. The different efforts should be criticised by the pupils, and where satisfactory the pupil should be encouraged to draft out working drawings and to execute the model to his own dimensions.

Drawing.—In all cases the pupils should work from their own drawings. This is a very important part of the work, and as much care should be given to drawing as to the benchwork. The boy should thoroughly understand the drawing and the relation of the various parts before beginning the construction of the model. In the early stages a simple dimensioned sketch might be employed. This gives a three dimensioned view of the model and is easily understood. Oblique projection or conventional isometric drawings could be taken next.

At the same time simple plan and elevation might be taken in conjunction with these, so that the pupil might be able to grasp the orthographic projection more thoroughly. Most of the later drawings will be plans and elevations with sections or with isometric projections to show more clearly any part requiring it. Template work (*i.e.* the use of a shape round which the pupil draws a line on his work, instead of setting it out to dimensions taken from the drawing) should not be countenanced at all.

Individual Instruction.—Most of the instruction will be individual, and very little of it can be taught in class. The pupils will show varying abilities, and the teacher will have to deal with each individual as required. Only in the early stages will class demonstration be of any great value, for very soon the children arrive at different stages of the work and the demonstration is either premature or unnecessary. When necessary the teacher should gather round him those who require it, and leave the other pupils to proceed with their work. It is better for the pupil to find out the correct method of working than to work merely to the teacher's instruction. "Learn by doing" should be the motto throughout, and only after the pupil has attempted to perform the work and has failed, should the teacher step in and say " Do it this way."

In demonstrating a tool exercise to a pupil, the teacher should do this on a separate piece of wood, not on the pupil's model, as this is doing the work for the pupil and not giving him an opportunity of carrying out the instruction received.

Correct Working Position.—The teacher should see that the pupil assumes a correct position whilst working at the bench, and any faulty position likely to injure correct physical development should be corrected. Pictures illustrating the correct way of holding a tool for a particular operation might be displayed on the walls, and where a pupil is not holding the tool correctly his attention should be drawn to the picture.

Specimen Models.—In some conspicuous place in the room should be hung specimen models of the course—correctly executed to size. A valuable addition to these are **development models,** *i.e.* models showing the different stages of the work, or showing the method of setting out the different parts.

Bench Notes.—Bench Notes written on cards corresponding to each model—showing the sequence of the different exercises in the development of the model—will give the child sufficient data to let him proceed with the work without waiting for the teacher's instruction. This fosters a habit of independence and self-reliance in the pupil and gives the teacher more time to attend to the backward pupils.

Running concurrently with the benchwork should be lessons on the construction and use of the tools, and on the wood used. This should not take up too much of the class time as the lesson is essentially a **handwork** lesson.

Records.—Each model when finished should have a mark assigned to it, and the pupil should keep a record of the marks obtained. In estimating a pupil's value from the point of view of Educational Handwork the following points will have to be taken into account: (1) Practical bench work, (2) Drawing, (3) Oral work in concurrent lessons, (4) Aptitude, (5) Character in the workshop and care of tools and apparatus.

SCHEME OF WOODWORK MODELS WITH CONCURRENT LESSONS.

No.	Name of Model.	Wood.	Drawing.	Concurrent Lessons on Tools and Material.
1.	Sandpaper Block .	Yellow Pine	Oblique Projection	Grain of the Wood. Rule. Square
2.	Key Label .. .	,, ,,	,, ,,	Jack Plane, Bradawl
3.	Turn Buttons . .	,, ,,	Plan and Elevation	Tenon Saw. Setting a Jack Plane
4.	Plant Label .. .	Redwood	,, ,,	Chisels. Parts of a Tree
5.	Reel Holders .	Basswood	Front and Side Elevations	Cross-section of a Tree. Marking Gauge
6.	Seed Label	Redwood	Front and Side Elevation, Oblique Projection	Yellow Pine
7.	Match Box Holder...	Basswood	Front and Side Elevation	Redwood. Brace and Centre Bit
8.	Round Ruler ...	Kauri Pine	Plan and Sections	File. Glass Paper. Teeth of Saws
9.	Pointer	,, ,,	Plans and Sections	Kauri Pine
10.	Tool Rack	Redwood	Plan and Elevation	Trying Plane, Jack Plane, and Smoothing Plane
11.	Candle Stick .	Basswood	,, ,,	Screws and Screwdrivers. Plane Irons
12.	Toothbrush Rack .	Redwood	Plan and Elevation and Section	Boring Bits
13.	Clothes Hanger	Basswood	Plan, Elevation, and Sections	Spokeshave. Bow Saw
14.	Ink Stand	,,	Plan and End Elevation	Gouge. Basswood
15.	Pin Tray	,,	Plan and Sectional Elevation	General Characteristics of British Timber Trees
16.	Letter Holder ..	Sycamore	Plan and Elevation and Section	Leaves
17.	Test-tube Stand ..	Redwood	Plan and Elevation	A Leaf, its Functions

No. Name of Model.	Wood.	Drawing.	Concurrrent Lessons on Tools and Material.
18. Nail Box	Redwood	Isometric View	Nails, Pincers, and Hammers
19. Tee-square	Mahogany	Plan and Part Elevation	Glue and Gluing
20. Table Mat	Mahogany Sycamore Walnut	Plan and Section	Felling Timber
21. Paper Knife	Sycamore	Plan and Elevation and Section	Seasoning Timber
22. Garden Dibble	Redwood	Front and Side Elevation, Isometric View of Joint	Shrinkage in Seasoning
23. Hat Peg	Oak	Plan and Elevation	Defects in Timber
24. Towel Rail	Sycamore	,, ,,	Oilstones
25. Book Cradle	Basswood	Elevations	Oak
26. Handkerchief Box	,,	,,	Beech
27. Alarm Clock Bracket	,,	Elevations, Plan and Isometric View of Joint	Elm
28. Tea Tray	,,	Plan and Elevations	Ash
29. Book Stand	Sycamore	Elevations and Oblique Projection of Joint	Sycamore
30. Newspaper Rack	Basswood and Walnut	,, ,,	Walnut

NOTES ON DRAWING, BENCH WORK, AND CONCURRENT LESSONS IN SCHEME OF 30 MODELS.

MODEL 1. **Sandpaper Block.**

MODEL 2. **Key Label.**

Rough wood: 12 in. × $2\frac{1}{2}$ in. × $\frac{3}{4}$ in. Yellow Pine. (Both models made from one piece of wood.)

Drawing.—Prepare oblique projections, scale full size, as shown in Figs. 303, 304.

Make sketch showing method of setting out (Fig. 305).

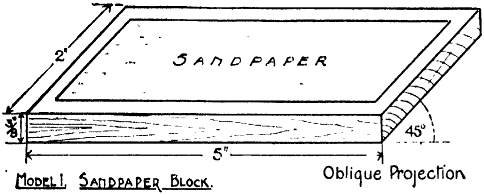


Fig 303.

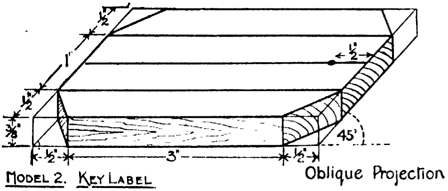


Fig. 304.

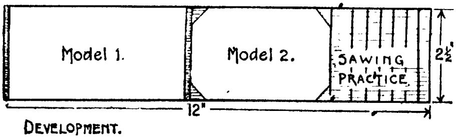


Fig 305.

In drawing, the following lines are used:—

(*a*) Heavy line denotes the outline.

(*b*) Thin line used for construction and for projectors.

(*c*) Chain line denotes a hidden line.

Bench Notes.—1. Plane up the best side with Jack Plane. Test with eye and straight-edge. This is called FACE SIDE. Mark as in Fig. 306. Face mark.

2. Plane up one edge at right angles to face side. Test with eye, straight-edge, and try-square. This is called FACE EDGE. Put on edge mark (Fig. 306).

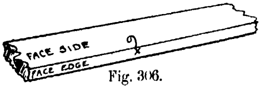


Fig. 306.

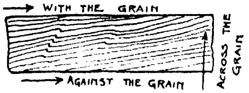


Fig. 307.

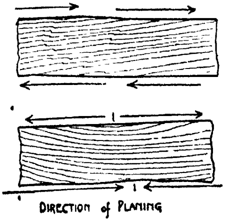


Fig. 308.

3. Gauge to width and plane off.

4. Gauge to thickness and plane off.

5. With pencil, mark off portions for Models 1 and 2.

6. On waste portion, square lines across and practice sawing to lines with tenon saw.

7. Saw off portions for Models 1 and 2, sawing on *waste side of line.*

8. Cut out piece of sandpaper to size and glue in position on Model 1.

9. Gauge lines shown on Model 2 on both sides.

10. Set off lines for corners, pare off vertically with paring chisel.

11. Mark position of hole and bore with bradawl.

Notes on Concurrent Lessons.

Grain of the Wood.—Show specimens in which the grain is clearly marked, *e.g.* oak, ash, and elm, and obtain the meaning of "with the grain," "against the grain," "across the grain" (Fig. 307). By experiment find easiest direction of cleavage.

Straight grain and twisted grain—method of working (Fig. 308). Illustrate by planing suitable specimens.

Rule.—Revise the measurements, English and metric. Give exercises in measuring and judging distances. Give mental exercises on addition and subtraction of fractions, *e.g.* $\frac{1}{2}$ in. + $\frac{1}{8}$ in., $\frac{3}{4}$ in. + $\frac{1}{16}$ in., $\frac{1}{2}$ in. − $\frac{1}{8}$ in, $1\frac{1}{4}$ in. − $\frac{3}{8}$ in., half of $1\frac{1}{4}$ in., quarter of $1\frac{1}{4}$ in.

Show specimens of joiners' folding rules.

Show correct way of setting off measurements from a thick edged rule.

Try-Square.—Blade and Stock.—Stock held in the hand when in use.

Blade.—Rectangular piece of sheet steel. "Blued," to prevent rusting.

Stock.—Rosewood or ebony, brass plate on inside edge of stock to prevent wear (Fig. 309).

Blade mortised into stock, fixed by three rivets and plates.

Testing a Try-Square.—Inside angle only guaranteed. Test by squaring a line on a piece of wood with a true edge. Test the line by turning square over to other side of line (Fig. 310). Test inside and outside edges. Show correct method of holding try-square.

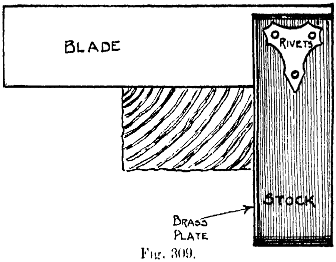


Fig. 309.

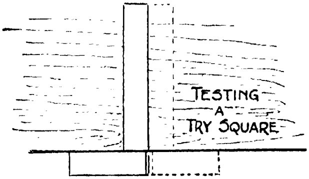


Fig. 310.

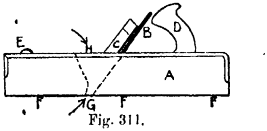


Fig. 311.

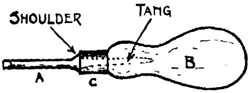


Fig. 312.

Jack Plane. *Parts.* (Fig. 311.)

(*a*) Stock or body, front part "toe" or "nose," back part "heel."

(*b*) Irons—cutting iron and cap iron—binding screw.

(*c*) Wedge, holding irons in position.

(*d*) Handle, mortised into stock.

(*e*) Boss, to take hammer strokes.

(*f*) Sole or under part of plane.

(*g*) Mouth in front of irons in the sole.

(*h*) Escapement through which shavings pass, called also the throat.

Name the different parts and illustrate their uses.

Bradawl. *Parts.* (Fig. 312.)

(*a*) Awl—steel prong.
(*b*) Wooden handle.
(*c*) Brass ferrule.

Awl.—Chisel pointed—sharpened from opposite sides.
Shoulder to keep the awl from pressing into the handle.
Flat tapered tang fixed in handle.

Ferrule.—Prevents the wooden handle from splitting.

Use of Bradawl.—Use with cutting edge across the grain. If inserted between the fibres, tendency to split the wood. Sharpen on the side of the oilstone to avoid hollowing the top of the stone.

MODEL 3. **Turn Buttons.**

Drawing.—Plan and Elevation of each button, side by side (Fig. 313).

Bench Notes.—Rough wood: 8 in. × 1¼ in. × 1 in. Yellow Pine.

1. Plane up wood to 1 in. × ¾ in.
2. Square lines 3½ in. apart for Button A and saw off square.
3. Set off oblique lines shown in elevation and pare to lines.
4. Bore and countersink hole for screw.

5. Proceed in same way for Button B, cutting bevels as shown in Figs. 314 and 315.

3 Door Buttons —

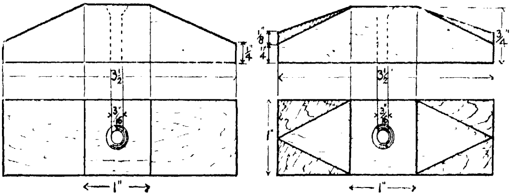


Fig. 313.

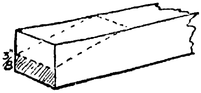


Fig 314.

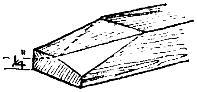


Fig. 315.

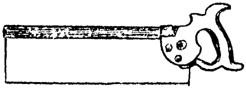


Fig. 316.

Lesson on Tenon Saw (Fig. 316).

Parts.—(*a*) Handle of wood.
(*b*) Back, of iron, steel, or brass.
(*c*) Blade of steel.
(*d*) Screws of brass.

Compare with hand saw and show use of back.

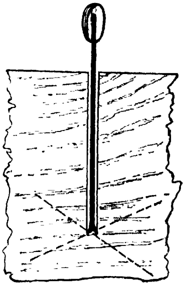


Fig. 317.

Show a specimen of saw screw and explain its advantages over rivets, as used in try-square.

Explain the "set" of the teeth and illustrate with a diagram, as in Fig. 317, the making of a saw kerf.

Setting a Jack Plane.—Set two planes, one coarse, the other fine, and ask a pupil to use each and state what difficulty he has.

Show how to remove the irons, thumb of left hand in the throat of the plane pressing on the irons, the other fingers on the sole of the plane. Strike on the boss or on the forepart of the plane with the hammer, holding the heel of the plane against the thigh.

Place the irons in position so that looking along the sole of the plane from the toe they appear as a fine black line. Tap the irons to position with the hammer, then drive the wedge firmly in.

Show how to remove the irons of a smoothing plane.

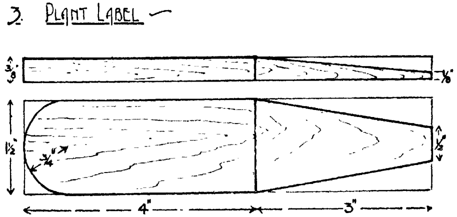


Fig. 318.

MODEL 4. **Plant Label** (Fig. 318).

Rough wood : 8 in. × 2in. × $\frac{5}{8}$ in., Redwood.

1. Plane to width and thickness.
2. Set out drawing on Face side as shown in plan.
3. With firmer chisel pare to semicircle, finishing with file and glasspaper.
4. Bevel the edges with chisel.
5. Bevel the face. Test all bevels with straight-edge.

Lesson on Chisel.

Parts.—(*a*) Handle of wood—(ash, beech, or boxwood).
(*b*) Steel blade with shoulder and tang.
(*c*) Brass ferrule to prevent splitting of handle.

Handle.—Various shapes and various woods according to particular use of chisel. Show octagonal, oval, and round handles (Fig. 319).

Blade.—Cast steel: Ordinary firmer chisel, flat. Paring chisel bevelled on edges (Fig. 321).

Show use of shoulder and method of fitting handle—need of having axis of handle true with the blade. The size of the chisel is taken from the width of the cutting edge.

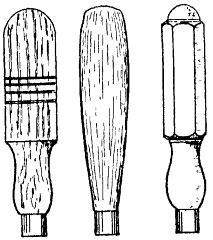


Fig. 319.

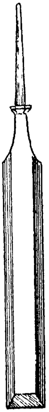


Fig. 321.

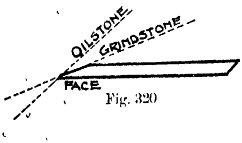


Fig. 320

Chisel sharpened on one side only: *Grindstone* bevel, broad. *Oilstone* bevel, narrow (Fig. 320).

Size of angle depends on the particular use of the chisel and the wood on which it is being used.

Generally speaking, for hard woods and where the chisel is subject to shocks and strains, the cutting angle will be greater than for soft woods and for light work.

Lesson on Parts of a Tree.

Roots.—Fix the tree, supply moisture and mineral matter in solution to the tree. Sap.

Trunk.—Body of the tree, protected by bark. Sap travels through the trunk.

Branches.—Support the *leaves*, *flowers*, and *fruit*. Show sketches of different trees, *e.g.* oak, birch, fir, and pine, noting particularly the characteristics of the trunk and shape of leaf.

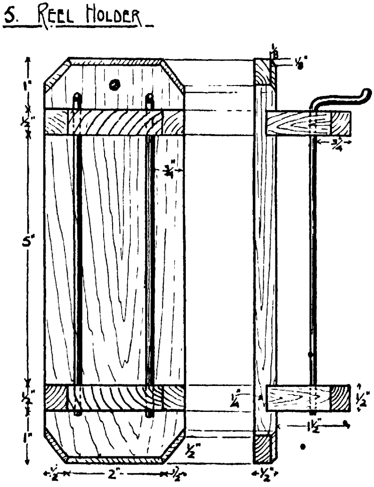


Fig. 322.

MODEL 5. **Reel Holder.**

Drawing.—Front and Side Elevations. Scale 1. (Fig. 322.)

Bench Notes.—Rough wood : 13 in. × 3½ in. × ¾ in. Basswood.

1. Plane to width and thickness.

2. Mark off and saw off pieces for back and brackets.

3. Set out lines for grooves and gauge depth. Test width with bracket pieces.

4. Saw sides of groove to required depth (saw on waste side of line). Remove waste with firmer chisel. Test bottom of groove with straight edge.

5. Square ends of brackets and fit in grooves. Pare off corners and bore holes for wires.

6. Chamfer corners and ends of back. Bore hole. Glue brackets in position. Test for perpendicularity of brackets.

7. Bend wires to shape and cut to length. Use galvanized wire (No. 10, S.W.G.)

Lesson on Cross Section of a Tree.—Prepare a cross section of Laburnum.

Sketch the outline of the section on blackboard, and as each part is named fill in the sketch as shown (Fig. 323).

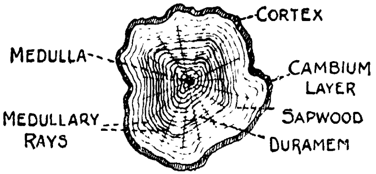


Fig. 323.

Parts.—1. The Bark (Cortex).
  2. Annual Rings, dark and light, autumn and spring growth.
    (*a*) Duramen or heartwood in middle.
    (*b*) Alburnum or sapwood on outside.
    (*c*) Cambium layer between bark and sapwood.
    (*d*) Medulla or pith at the centre of the annual rings.
  3. Medullary Rays running from medulla towards the outside.

Function of Parts.

Cortex—protects the cambium layer beneath.

Cambium layer—where the sap is converted into wood tissue.

Alburnum—newly-formed wood through which the sap passes on its way to the leaves.

Duramen—the hard wood of the tree.

Medullary Rays—bind the concentric growths together. In the early stages of the tree the sap travels through the medulla and medullary rays, but this ceases in the later development.

Various specimens of wood should be examined and the difference in the annual rings and medullary rays noted.

Note the medullary rays of the oak, beech, and sycamore. "Silver grain."

Lesson on Marking Gauge.

Parts—Stock, stem, screw, and spur. Show the method of setting making gauge and method of using. Show necessity for trailing the spur.

Show also the use of the thumb gauge and pencil gauge for rough work.

MODEL 6. **Seed Label.**

Drawing.—Oblique projection of top showing groove. Scale $\frac{1}{2}$. Front and Side Elevations. Scale $\frac{1}{2}$. (Shaft broken.) (Fig. 324.)

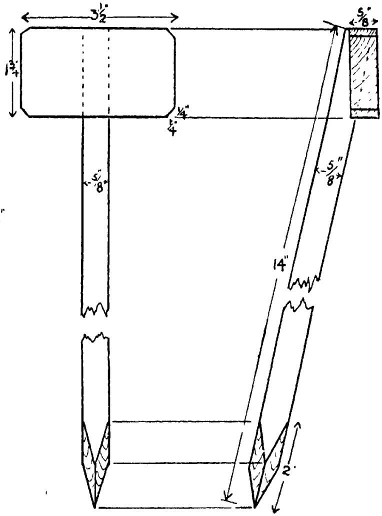
Bench Notes.—Rough wood: 4 in. × 2 in. × $\frac{3}{4}$ in.; $14\frac{1}{2}$ in. × $\frac{3}{4}$ in. × $\frac{3}{4}$ in. Redwood.

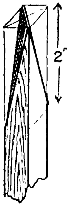
1. Plane up shaft to $\frac{5}{8}$ in. square.
2. Plane up and saw off piece for top $3\frac{1}{2}$ in. × $1\frac{3}{4}$ in. × $\frac{5}{8}$ in.
3. Set out lines for groove. Gauge depth. Saw and chisel out groove.
4. Square one end of shaft and draw diagonals. Square lines 2 in. from end. Pare off corners to diagonal as shown in Fig. 325. Finish by paring off corners to middle of diagonal (Fig. 326).
5. Glue shaft in position Pare off top of shaft flush with top piece.

Lesson on Yellow Pine.—Piece of Yellow Pine prepared to show longitudinal, transverse, and oblique sections.

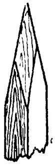
Educe from the children the various characteristics of the wood. Note colour, grain, texture, annual rings, resin, and knots. A table should be prepared in the Note Book, and as each tree is dealt with the facts should be tabulated.

6. SEED LABEL —





1st Stage
Fig. 325



Finish
Fig. 326.

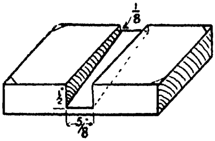
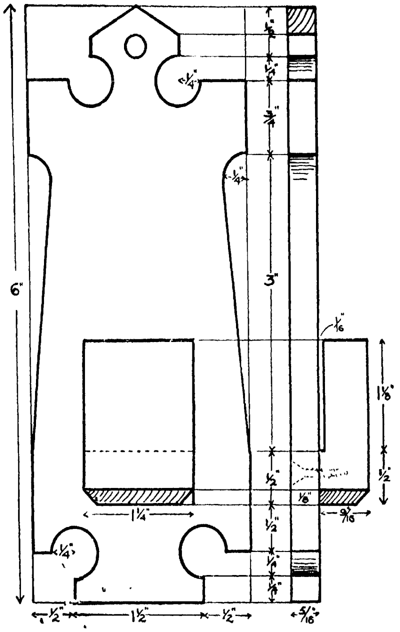


Fig. 324.

Wood.	Tree.	Characteristics of Wood.				Qualities.	Uses.	Where obtained.
		Colour.	Grain.	An. Rings.	Med. Ray.			
Yellow Pine (Weymouth P.) (American White P.)	Pinus Strobus	Pale straw	Clear, fine, silvery. Yellow flecks	Almost invisible	Almost invisible	Soft and easy to work Durable if kept dry Does not shrink much Does not warp or twist much Knots few but large and coarse	Internal Joinery Pattern Making Show Cases Body for Veneering Unsuitable for Outdoor Work	America. Exported from Quebec, St. Lawrence. and Ports in New England



7. Match Box Holder

Fig. 327.

The Tree (*Pinus Strobus*).—A picture of the tree and specimens or drawings of the foliage and cones should be shown.

General appearance.—Majestic, lofty, pyramidal, attains from 100 to 150 feet in height; trunk 8 to 12 feet in girth. Bark, greenish-white.

Foliage.—Leaves in clusters of five, long spines. Cones very long, with loosely arranged scales.

MODEL 7. **Match Holder** (Fig. 327).

Drawing.—Front and Side Elevations. Scale 1.

Bench Notes.—Rough wood: $6\frac{1}{2}$ in. × 3 in. × $\frac{1}{2}$ in., and 2 in. × $1\frac{1}{2}$ in. × $\frac{3}{4}$ in. Basswood.

1. Plane wood to $\frac{5}{16}$ in. thickness, not to width.
2. Set off drawing shown in front elevation leaving room for boring of side holes.
3. Bore all holes with centre bits.

Method of Boring:—

(*a*) Place point of centre bit on centre of hole.
(*b*) Hold brace vertically, left-hand on top.
(*c*) Turn the brace clockwise with right-hand, pressing gently with left-hand on top.
(*d*) When centre point appears at back of wood, reverse the wood and give one or two light cuts to cut the fibres.
(*e*) Return the wood to first position and bore right through.

4. Plane the wood to width and saw to length.
5. With tenon saw, cut out corners.
6. Pare off oblique lines with chisel.
7. Plane small piece to dimensions with smoothing plane.
8. With saw and chisel cut out recess at back.
9. Glue in position and when fixed bore hole and fasten with screw.

Lesson on Redwood.—Treat the subject as in former lesson on Yellow Pine.

Specimens of the different woods should be prepared, 12 in. × 1 in. × 1 in., and carefully weighed on a balance. The weight per cubic foot should be calculated and fixed on a label on the specimen.

Redwood.—Numerous names—Northern Pine, Red Fir, Yellow Fir, Scotch Fir, Red Pine; Riga, Dantzig, Swedish Pine, Deal or Fir.

Colour.—Bright yellow, with reddish tinge.

Grain.—Clearly marked. Resinous.

Annual Rings.—Clearly marked. Circular.

Knots.—Hard and resinous, turpentine smell, reddish brown colour.

Tree (*Pinus Sylvestris:* Northern Pine).—Evergreen, branching at top. Lower portion devoid of branches.

Bark, reddish-brown, usually brightest at top.

Leaves, long spines, growing in clusters 2 in. to 3 in. long; remain on tree two or three years.

Cones, one to three together near end of branch. Thick and short, 1 in. to 2 in. long.

Qualities and Uses.—Strong and elastic. Not liable to warping.

Used in general building and constructive work. Roofs, joists, floors, beams, window frames, sleepers, etc.

Imported from Dantzig, Memel, and Stettin, from Riga and Archangel, and from Christiana and Gefle.

By-products of Redwood are turpentine, resin, and Stockholm tar.

Lesson on Brace and Centre Bit.

Brace (Fig. 328).

Parts.—(*a*) Head of hardwood, generally fitted with ball bearings.
(*b*) Crank and handle.
(*c*) Chuck, consisting of jaws and screw nose.

Unscrew the nose and show how the conical ring inside closes the jaws. Jaws recessed to take the shank of the bit. Show correct method of fixing bit in position.

Centre Bit (Fig. 329).

Vary in size from ¼ in. to 2½ in. In common with other bits it has a square tapered shank to fit the jaws of the brace.

Parts.—(*a*) Shank.

(*b*) Centre—triangular prong.

(*c*) Nicker or cutter for cutting the circumference of circle.

(*d*) Lip or router for removing the core of the hole.

In action, the centre meets the wood first, then the cutter, and lastly the router. The cutter is sharpened on the inside with a fine file and finished with an oilstone slip. The router is sharpened on the top side.

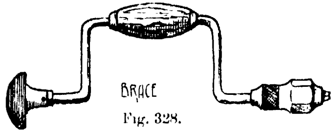
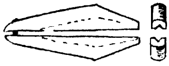


Fig. 328.



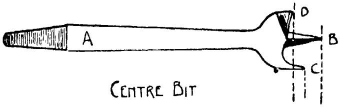


Fig. 329.

MODEL 8. **Round Ruler.**

Drawing.—Plan (broken) and Sections showing different stages of development (Fig. 330).

Bench Notes.—Rough wood: 13 in. × $1\frac{1}{4}$ in. × $1\frac{1}{4}$ in. Kauri Pine.

1. Plane up wood to $1\frac{1}{8}$ in. square.
2. Saw to length and pare ends flat. (Square Prism, Stage I.).
3. On ends inscribe circles; where circle cuts diagonals draw tangents and thus obtain inscribed octagon.

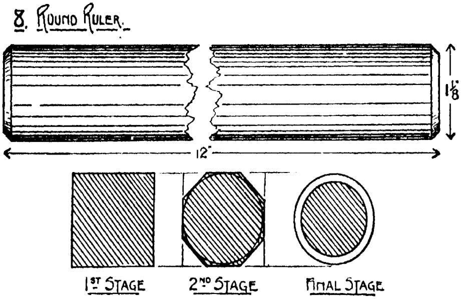


Fig. 330.

4. Gauge pencil lines along sides from corners of octagon.

5. Place square prism in vice, gripping two opposite edges (Fig. 331), and plane to lines (Octagonal Prism, Stage II.)

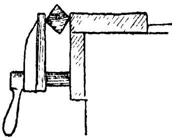


Fig. 331.

6. Holding octagonal prism on underside with left hand and with end against the bench stop, plane off all edges with smoothing plane. Continue with plane set fine till model is practically cylindrical.

7. File off all ridges. Feel for ridges with tips of fingers.

8. With coarse glass paper wrapped round the model, smooth off the remaining ridges. The direction of working must be round the model.

9. With fine glass paper finish off the surface, working along the model.

10. Set off chamfers on end, and work with knife, file, and glass paper.

Lesson on Files.—The file should only be used as a finishing tool and should only be brought into use when the knife, chisel, or plane have been used to their fullest extent.

Files named according to fineness of teeth—coarse, second-cut, and smooth.

Files of different shapes named according to cross-section.—Flat, square, triangular, half-round and round. Note the safety edge, explain its use.

Files made of cast crucible steel, hard tempered, very brittle.

Rasp.—Coarse file, teeth cut differently from ordinary file.

Clogging.—On resinous woods the file soon becomes clogged, particles of wood and resin filling the teeth. To remove, dip the file in warm water and clean with a wire scratch brush. The file must then be carefully dried. Another method is to take a piece of zinc plate and by pressing it along the teeth push the wood out. The soft zinc does not damage the edge of the teeth (Fig. 332.)

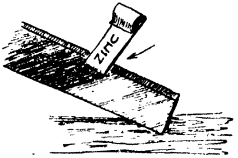


Fig. 332.

Lesson on Glass Paper.—Powdered glass or flint glued on to stout paper. Graded from 3 (coarse) by halves to ½, thence 0 and 00 fine. Should be used on a rubber (piece of cork or a piece of wood with rubber pad glued on) for flat surfaces. Work along the grain.

After sand papering, plane or chisel should not be used on the work; particles of sand or glass adhere to the surface.

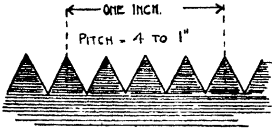


Fig. 333.

Lesson on Teeth of Saws.—Have rip, half-rip, cross-cut, tenon, and dovetail saws to illustrate the lesson.

Size of Teeth vary with the saw. Pitch of teeth (Fig. 333).

Rip	3 to 3½	to one inch
Half-rip	4 or 5	,, ,,
Cross-cut	7 or 8	,, ,,
Tenon	11 or 12	,, ,,
Dovetail	15 to 20	,, ,,

Set of Teeth.—Each tooth is bent out of the plane of the blade, alternately in opposite directions to give clearance for the blade and to prevent friction (Fig. 317). Teeth are set by means of a hammer and block or by a special tool called a saw set (Fig. 334).

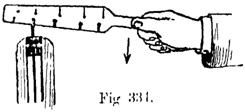


Fig. 334.

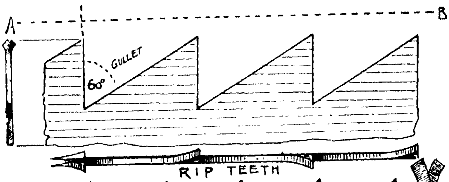


Fig. 335.

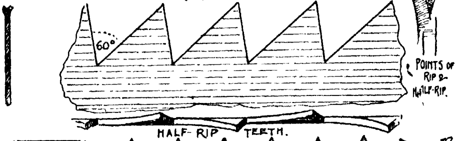


Fig. 336.

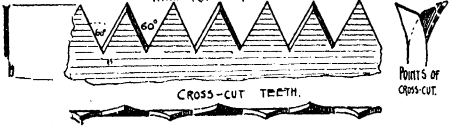


Fig. 337.

Shape of Teeth:—

Rip Saw (Fig. 335).—Leading face at right angles to *AB* and flat. Cuts only on the forward thrust. Has chopping action; shaped specially for sawing along the grain.

Half-rip (Fig. 336).—Front face slightly off the perpendicular and flat, as in case of Rip. Offers less resistance but does not cut so quickly.

Cross-cut (Fig. 337).—Front face inclined to *AB*, not flat, as in Rip and Half-rip. Saw file held inclined to blade when sharpening the saw, forming bevels on back of one tooth and on front of the other. Saw cuts through the fibres on both the down and the up stroke. For cutting across the grain.

Tenon and Dovetail Saws.—Teeth shaped as in Cross-cut. The saws are sharpened with a file, triangular in section, so that the "gullet," or the angle between the teeth is constant, viz. 60°.

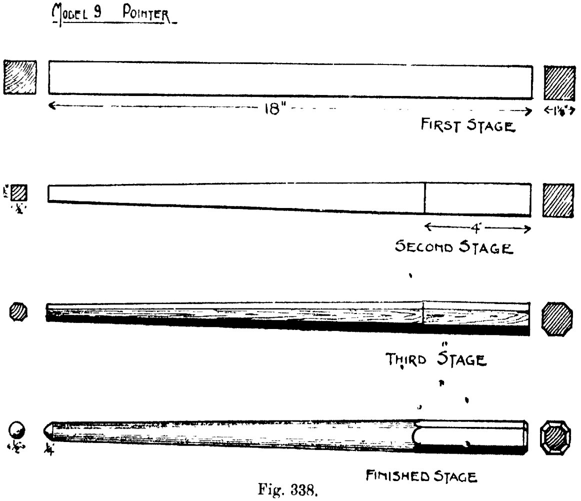


Fig. 338.

MODEL 9. **Pointer.**

Drawing.—Development Drawing showing Plans and Sections of the work at different stages. Scale ½. (Fig. 338.)

Bench Notes.—Rough wood: 19 in. × 1$\frac{1}{4}$ in. × 1$\frac{1}{4}$ in. Kauri Pine.

1. Plane up wood to 1$\frac{1}{8}$ in. square and saw to length. (Stage I.)
2. Set off portion for handle and $\frac{1}{2}$ in. square on small end. Taper with plane. (Stage II.)
3. Set off octagon on each end. Plane off edges with smoothing plane. (Stage III.)
4. Plane off tapered portion to round. Finish with file and glass paper. Shape point with knife or chisel and finish off with file and glass paper.
5. Chamfer end of handle with paring chisel.

Lesson on Kauri Pine.

Apparatus required.—Samples of Kauri Pine showing sections. Pictures of the tree and leaves, and specimen of kauri gum (dammar).

Colour.—Reddish straw colour. Sapwood distinctly marked.

Grain.—Fine straight hard grain, takes a fine silky finish.

Annual Rings.—Clearly visible.

Medullary Rays.—Very fine, hardly visible.

Knots.—Good quality wood very free from knots.

Characteristics.—Aromatic odour, shrinks little and stands well when properly seasoned. Heavier than redwood.

Tree (Dammara Australis).—Wrongly called Pine, allied to monkey puzzle tree (*Araucaria*). Native of New Zealand, large quantities in North Island, shipped from Auckland. Pyramidal in shape, branches in whorls; lower branches die away. Foliage tough, leathery, dark and dense; leaves resemble the Box.

Dammar, Kauri Gum.—Like the Northern Pine and Larch, the Kauri Pine exudes a thick fluid which hardens on exposure into masses of opaque gum. Used in the manufacture of varnish.

MODEL 10. **Tool Rack.**

Drawing.—Plan and Elevation. Scale $\frac{3}{4}$. (Fig. 339.)

Bench Notes.

Rough wood: (*a*) 12 in. × 3$\frac{1}{4}$ in. × $\frac{3}{4}$ in.} Redwood.
(*b*) 9 in. × 1$\frac{1}{4}$ in. × 1$\frac{1}{4}$ in.}

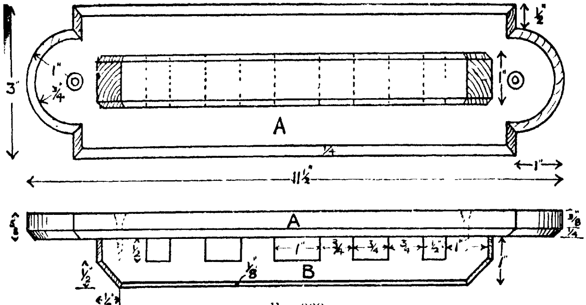


Fig. 339.

1. Plane up *A* to width and thickness and set out shape shown in elevation.

2. Saw out corner pieces as shown in Fig. 340 and pare to lines.

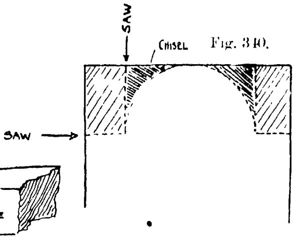


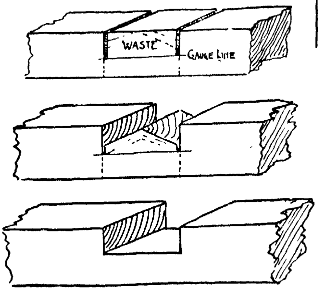
Fig. 340.

3. Gauge pencil lines for bevels. Plane off long bevels, work short and round bevels with paring chisel and file.

4. Bore and countersink holes for screws.

5. Plane up piece *B* to width and thickness and set out notches shown in plan.

6. Saw with tenon saw



METHOD OF REMOVING WASTE

Fig. 341.

on waste side of notches and remove waste with firmer chisel. Wide notches worked as shown in Fig. 341. Finish ends and bevel edges with plane and chisel.

7. Glue and screw piece *B* in position.

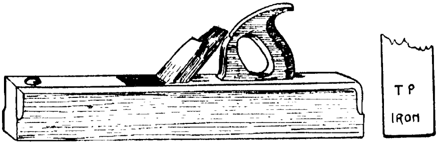


Fig. 342.

Trying Plane

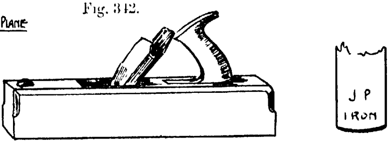
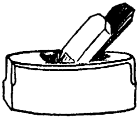


Fig. 343.

Jack Plane



Smoothing Plane Fig. 344.

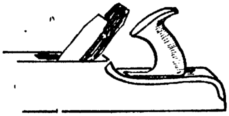


Fig. 345

Sunk Handle

Lesson on Trying, Jack, and Smoothing Planes (Bench Planes).—Compare sizes*:—

Trying Plane	22 in. long,	2½ in. iron.	(Fig. 342.)
Jack Plane	17 in. long,	2¼ in. iron.	(Fig. 343.)
Smoothing Plane	7½ in. long,	2 in. iron.	(Fig. 344.)

* These are standard sizes. The tools in the M. T. room will probably be smaller.

Shape.—The Trying Plane and Jack Plane are rectangular in shape. The Smoothing Plane has convex sides.

Wood.—All are made of beech, thoroughly seasoned and specially selected. Medullary rays seen on end are more or less perpendicular to the sole.

Handle.—Trying plane has a full or closed handle mortised into the stock. Jack plane often has open handle, sometimes sunk handle (Fig. 345).

Smoothing Plane.—Wooden variety, no handle. American iron Smoothing Plane fitted with open handle.

Irons.—All have cutting iron and cap iron held by wedge. Trying Plane and Smoothing Plane have cutting edge straight (corners slightly rounded to prevent them marking the wood. Fig. 342). Jack Plane has convex cutting edge (Fig. 343). In removing the irons the Jack and Trying Planes are struck on the top of the plane, the Smoothing Plane on the heel.

Uses.—

Jack Plane.—For removing the first rough surface and obtaining an approximately true surface.

Smoothing Plane.—For finishing off and for obtaining true surfaces on small work, and for smoothing end grain.

Trying Plane.—For finishing off large work after the Jack Plane, when a true surface is required. For use on the shooting board and for making butt joints for gluing.

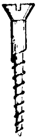


Fig. 346*a*.

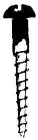


Fig. 346*b*.

Lesson on Screws, Screwing, and Screwdrivers.

Screws.—Parts of a Screw.

A. *Head.*—Two varieties (1) Round headed (Fig. 346*a*), in iron (usually japanned) and brass. Used for fixing bolts, locks, and for ornamental purposes; (2) flat headed (Fig. 346*b*), in iron or brass. Underside of head conical of constant angle.

Fig. 347.

B. *Shank.*—Screwed for about two-thirds of length. Screw has gimlet point. (Compare with old-fashioned screw with flat end.)

Length of screw measured over all varies from $\frac{1}{4}$ in. to 6 in. Size according to gauge of shank ranging from 0 to 30. Nos. 6-14 most commonly used.

Screwing.—In fixing two pieces of wood with screws, a hole should be bored through the top piece with a pin bit large enough to allow the screw to pass freely. The top of the hole should be countersunk with the countersunk bit to receive the head of the screw (if flat-headed screws are used). A hole is bored in the lower piece with a bradawl to assist the screw in starting (Fig. 347).

Screwdrivers :—

Parts.—(*a*) Blade, (*b*) Handle, (*c*) Ferrule.

Blade.—Of steel tempered to stand a strain.

(Compare the shapes of the Cabinet and London patterns.)

Handles.—Oval, plain, or fluted shapes. In beech or in boxwood.

Ferrule.—Thick brass ferrule—notched to receive part of the blade to reduce strain on tang and on inside of handle.

Point.—Ground on both sides to fit slot of screw.

Use of Screwdriver.—The axis of the driver should always be in line with the axis of the screw.

MODEL 11. **Candle Stick.**

Drawing.—Plan and elevation. Scale 1. (Fig. 348.)

Bench Notes.—Oblique projection of half-lap joint.

Rough wood : For feet, 12 in. × $1\frac{1}{2}$ in. × $\frac{7}{8}$ in. } Basswood.
For top, 4 in. × 4 in. × $\frac{1}{2}$ in. }

1. Plane up wood for feet to $1\frac{1}{4}$ in. × $\frac{5}{8}$ in.
2. Set out lines for joint. Saw and cut out with chisel.
3. Work notch on underside as shown in drawing.
4. Saw off ends and pare to shape. Bore finger hole.
5. Plane up wood for top and set out circle.
6. Saw off waste, tangentially to cirle, with Tenon saw. Pare to circle and finish with file.

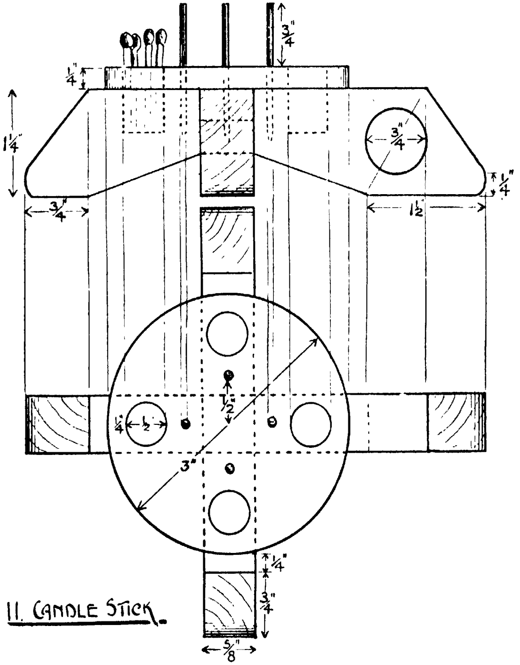


Fig. 348.

7. Glue joint and glue top in position.

8. Bore match holes. (Use a nail driven into a piece of wood to gauge depth.)

9. File off the heads of four 1½ in. wire nails and drive in position.

Lesson on Plane Irons.—Let each boy extract the irons from his Jack Plane and examine.

"Irons" consist of *Cutting Iron* and *Cap* or *Cover Iron* clamped by a screw working in a brass nut (Fig. 349).

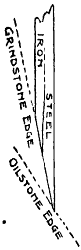


Fig. 349.

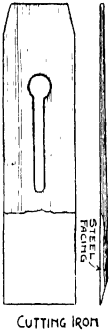


Fig. 350.

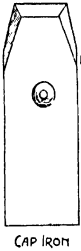


Fig. 351

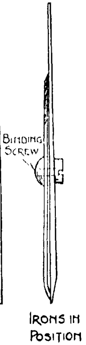


Fig. 352.

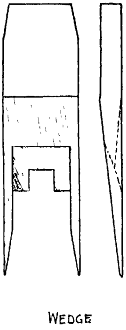


Fig. 353.

Unscrew the irons and notice the following points:—

Cutting Iron (Fig. 350).—Rectangular with top corners taken off. Slotted to receive the head of the binding screw. Thicker at the cutting end. Two bevels made by grindstone and oilstone. (Fig. 351.)

Made of wrought iron faced with "cast steel." (Note the welding line on face and sides.) (Fig. 350.)

Reasons for combination of metals:—

1. Reduces labour of grinding.
2. If composed entirely of cast steel would be liable to chip when struck with the hammer.

Cap Iron (Fig. 352).—Rectangular in shape; shorter than cutting iron. Arched at lower end but flat on edge, fitting closely against cutting iron. Edge thin but not sharp.

Made of steel in order to keep its shape when screwed in position.

Brass head of screw riveted or brazed in position.

Use of Cap Iron:—

1. To break the fibres of the shaving and prevent splitting.
2. To stiffen the cutting iron near the cutting edge and prevent "chattering."

Wedge (Fig. 353).—Made of Beech, should be a good fit and should not obstruct the passage of the shavings.

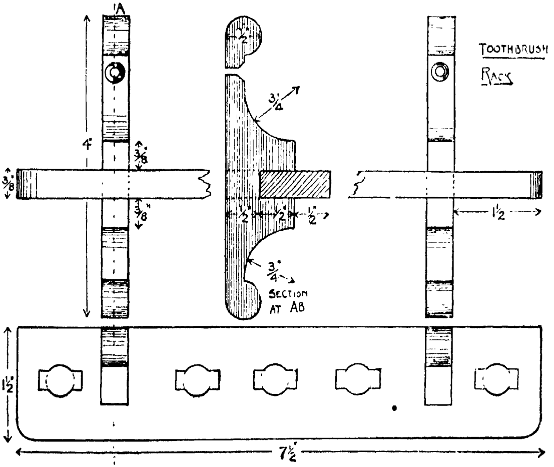


Fig. 354.

MODEL 12. **Tooth Brush Rack.**

Drawing.—Plan and Elevation and Section. Scale 1. (Fig. 354)

Bench Notes.—Rough wood: $8\frac{1}{4}$ in. × 3 in. × $\frac{5}{8}$ in. Basswood.

1. Plane up face and edge and thickness.
2. Gauge $1\frac{1}{2}$ in. for shelf. Saw off and plane to line.
3. Plane up edge on remaining piece, and set out lines for supports.

7. Chamfer portion *A* with chisel and spokeshave. Bore holes. Glue and screw to *B*.

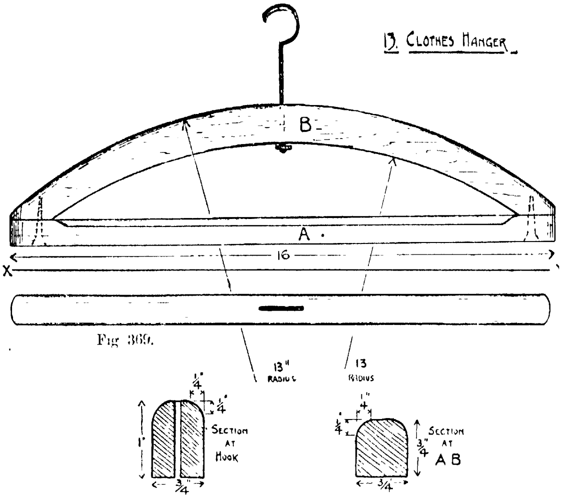


Fig 369.

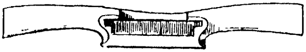


Fig. 370.

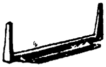


Fig. 371.

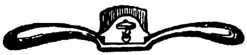


Fig. 372.

Lesson on Spokeshave.

Two kinds:

Wooden.—Stock of beech or boxwood. (Fig. 370.)

Metal. — Stock of iron. (Fig. 372.)

Wooden Spokeshave.—Compare with plane. Stock and iron.

Iron held in position by two tapered tangs at right angles to blade, passing through holes in stock. (Fig 371.)

Blade, narrow; sharpened on one side on narrow oilstone

Thickness of cut regulated by tapping both tangs with the hammer.

Sole or face of wooden spokeshave round and suitable for both convex and concave curves.

Iron Spokeshave: American Pattern.

Iron flat, held in position by a screw.

Sharpened like a plane iron.

Sole of iron spokeshave flat. Suitable only for convex curves.

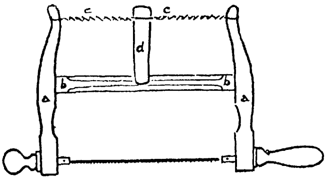


Fig 373.

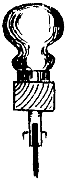


Fig. 374.

Fig 375

Lesson on Bow Saw.—Show the unsuitability of tenon saw and hand saws for sawing curves. For curves the blade must be narrow. Hand saw with narrow blade would lack rigidity, hence necessity for some means of holding the thin narrow blade in tension.

Parts.—(1) Frame for holding and tightening the blade.
(2) Blade or web held by pins in slots in handles. (Fig. 374.)

Frame consists of (*a*) Sides (Fig. 373), (*b*) Spreader, (*c*) Bow-string, (*d*) Lever or twitch for twisting the bow-string.

Remove the saw blade and show the action of the bow-string by fixing a small pocket spring balance between the handles, or a piece of stout elastic with paper indicators to show the tension.

The blade is thin and flexible, with teeth well "set." Back edge of blade ground thinner. (Fig. 375.) Blade must always be in one plane, never used twisted.

MODEL 14. **Ink Stand.**

Drawing.—Plan and End Elevation. Scale ½. (Fig. 376.)

Bench Notes.—Rough wood: 10½ in. × 7 in. × 1⅛ in. Basswood.

1. Plane up wood to 1 in. thick and saw off piece along length to make feet ¼ in. thick.

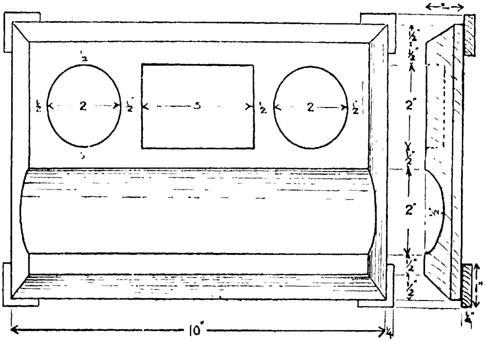


Fig. 376.

14 Ink Stand.

2. Plane up to 10 in. × 6½ in. × 1 in., using smoothing plane on ends.

3. Set out lines shown in plan.

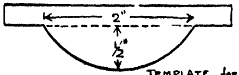


Fig. 377. Template for Pen Groove.

4. Make holes for ink bottles by first boring 1 in. holes to depth and finish to line with gouge (inside ground); finish bottom of hole with firmer chisel. Middle hole bored, sides finished with paring chisel.

5. Groove for pens cut out with gouge (outside ground). Make template (Fig. 377) to test depth. Finish with sandpaper on block planed to shape of groove.

6. Bevel edges with plane, long edges first.

7. Saw and pare pieces 1 in. × 1 in. × $\frac{1}{4}$ in. for feet and glue in position.

8. Fit pieces of green felt in the holes.

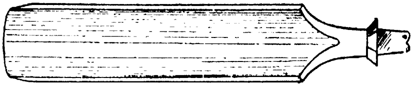


Fig. 378

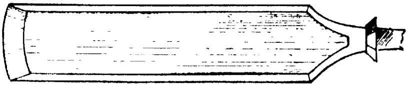


Fig. 379.

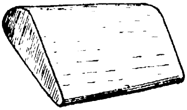


Fig. 380.

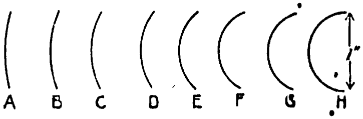


Fig. 381

Lesson on the Gouge.—Compare with firmer chisel.

Blade, shoulder, tang.
Handle and ferrule.

Blade.—Shaped like hollow chisel blade. Section of blade forms arc of circle. Curvature differs. Fig. 381 shows sectional curves in which gouges are made. Size of gouge measured from corner to corner of cutting edge.

Gouges are of two kinds—(1) Ground inside, incannelled. (Fig. 379.) (2) Ground outside. (Fig. 378.)

Uses :—

(1) Incannelled gouge used for paring to a particular curve.

(2) Outside ground gouge used for hollowing.

Sharpening :—

(1) Incannelled gouge, ground on special thin round stone, finished with oilstone slip. (Fig. 380.)

(2) Outside ground, ground on ordinary stone, set on ordinary oilstone with a rolling motion; inside finished with slip held close against the inside of the gouge.

Lesson on Basswood.—Known under several names—Basswood, Canary Wood, Canary Pine.

Colour.—Hardwood, greenish yellow; sapwood, pinkey-white.

Annual Rings.—Hardly visible. *Medullary Rays* very fine, hardly visible.

Grain.—Fine and straight; works easily and takes a smooth finish.

Characteristics.—Warps and twists a great deal in seasoning; durable if kept in dry state; no odour; weight, similar to redwood.

Tree (*Tilia Americana*).—Native of Canada and Atlantic States. Like the English Lime only leaves are larger; often 80 feet high. Leaves, heart-shaped, serrated edges. Bark has well formed bast, used for making ropes and matting.

Basswood used for cabinet making, indoor fittings, pattern making.

MODEL 15. **Pin Tray.**

Drawing.—Plan and Sectional Elevation. Full Size. (Fig. 382.)

Bench Notes.—Rough wood: 7 in. × 6 in. × 1 in. Basswood.

1. Plane wood to thickness.

2. Draw hexagon and set out figure shown in plan. (N.B.—Arrange drawing so that one diagonal runs with the grain.)

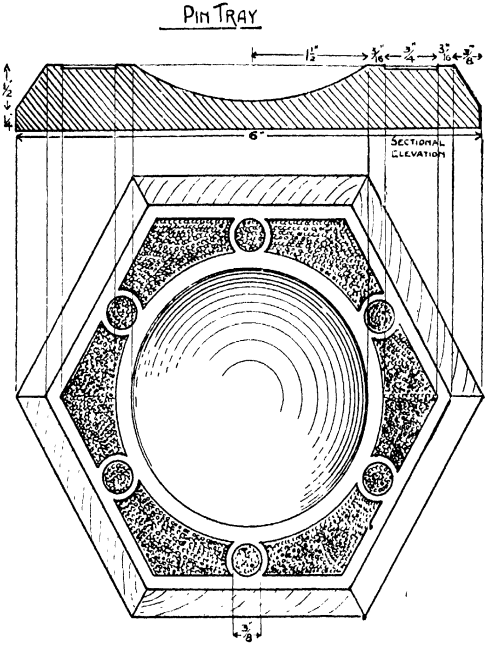


Fig. 382.

3 Saw to hexagon with tenon saw and finish edge with smoothing plane.

4. Hollow out centre portion ($\frac{3}{8}$ in. deep) with outside ground gouge. Make template of cardboard or tin as in Model 14. Finish with glass paper.

5. Incise edges of matted pattern with knife and punch to even depth with matting punch made by filing a nail with the three-cornered file as shown in Fig. 383.

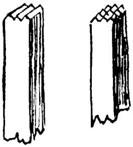


Fig 383.

Lesson on General Characteristics of British Timber Trees.—Where possible the children should be taken to see the trees, both in summer and winter, and the following points should be noted:—

1. Massing of foliage and general shape of the tree.
2. Shape of leaf.
3. Flower and fruit or seeds (in spring and summer).
4. Buds and arrangement of branches (in winter).
5. Bole of the tree. Bark.

Where it is impossible to view the tree itself, photographs or sketches of trees and dried specimens of the leaves and seeds should be shown.

MODEL 16. **Letter Holder.**

Drawing.—Plan and Elevation with Section, Scale 1. (Fig. 384.)

Bench Notes.—Rough wood:

$8\frac{1}{2}$ in. × 6 in. × $\frac{1}{2}$ in.
grain running short way } Sycamore.
$8\frac{1}{2}$ in. × $1\frac{1}{4}$ in. × $\frac{1}{2}$ in.

1. Plane up large piece to $\frac{1}{4}$ in. thickness.
2. Saw into three pieces (two sides and base).
3. Set out shape of sides shown in elevation. Bore holes, saw and pare to lines.
4. Plane base piece to size and pare ends to shape.
5. Glue sides to base.
6. Plane wood for feet, saw and chisel out notch. Shape concave curves with chisel and gouge (incannelled), convex curves with chisel and file.
7. Glue feet in position.

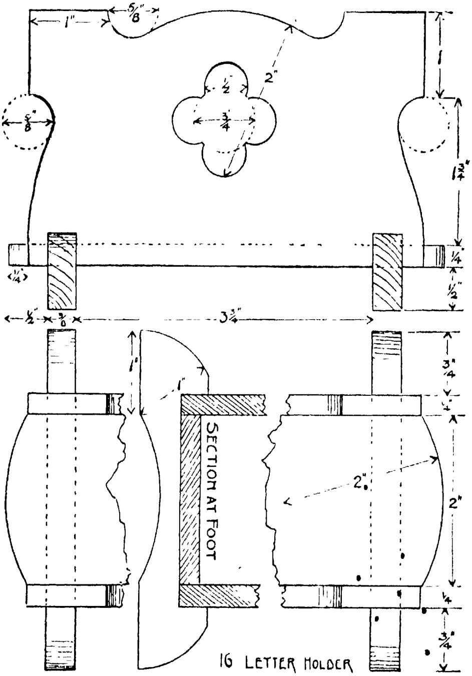

5/8"
1"
2"
1/2"
3/4"
5/8"
1
1 3/4"
1/4
1/4
1/2"
1/2"
3/8
3 1/4"
1"
1"
3/4"
1/4
SECTION AT FOOT
2"
2"
1/4
3/4"
16 LETTER HOLDER

Fig. 384.

Lesson on Leaves.

(*a*) Soft woods from needle-leaved trees—pines and firs.

(*b*) Hard wood from broad-leaved trees.

Show specimens of the following leaves, and let the pupils sketch them in their note books.

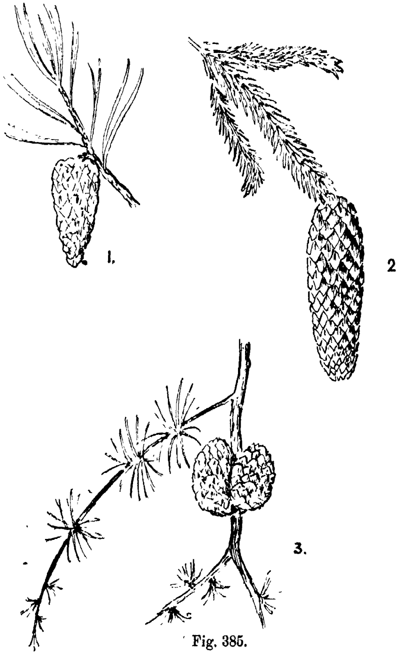


Fig. 385.

Soft Woods (Fig. 385).—(1) Northern pine. (2) Fir tree (3) **Larch.**

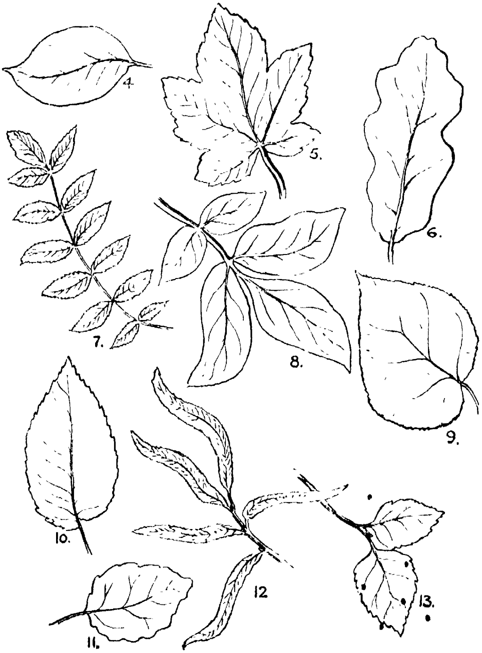


Fig. 386.

Hard Woods (Fig. 386).—(4) Beech. (5) Sycamore. (6) Oak. (7) Ash. (8) Walnut. (9) Lime. (10) Elm. (11) Poplar. (12) Willow. (13) Birch.

3. Set out notches in sides. Saw and chisel out middle notch.

4. Nail sides and ends with 1 in. oval brads. Punch heads in with nail punch.

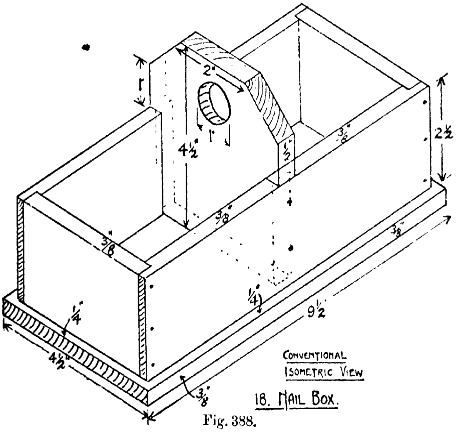


Fig. 388.

5. Plane handle to width and thickness. Set out notches in sides and saw out. Pare off corners and bore finger-hole.

6. Plane up base, glue and nail in position.

7. Fix handle and nail through sides.

Lessons on Nails and Nailing. Pincers.—Many varieties of nails. The following are the commonest:—

Cut Clasp Nail (Fig. 389).—Rectangular section, square point.

Wrought Nails (Fig. 390).—Shank similar to cut clasp; made from rolled sheet iron or steel; pointed at end. Metal of fibrous nature allows of point being clinched over. Head bigger than cut clasp nail.

Cut Brads (Fig. 391).—Flat rectangular head projecting on one side only and square at point. Drive in clean; used principally for floors.

French Nails made from wire, called also *wire nails.* Round French nails (Fig. 392), flat round head, shank fluted near top; pointed. Used mostly for packing cases. Oval French nails (oval brads) (Fig. 393), elliptical in section. Head ridged, shank grooved to increase holding power; pointed. Handy for manual training purposes.

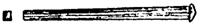


Fig. 389.

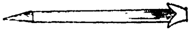


Fig. 390.

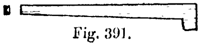


Fig. 391.

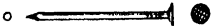


Fig. 392.

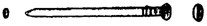


Fig. 393.

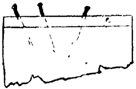


Fig. 394.

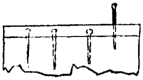


Fig. 395.

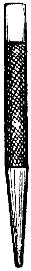


Fig. 396.

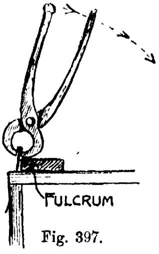


Fig. 397.

Nailing.—The nail should be driven with its greatest width along the grain, to avoid splitting.

Fig. 394 shows correct method of nailing. In Fig. 395 the nails are more easily drawn out.

Nail Punch or *Nail Set* (Fig. 396).—Used to drive the head of the nail below the surface of the wood.

Pincers consist of two bent levers acting on the rivet as a fulcrum. Fig. 397 shows the correct method of extracting a nail. The convex part of the jaw is used as a fulcrum, and the handles are depressed. The small piece of wood is to prevent bruising of the work.

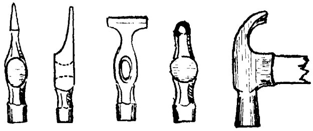


Fig. 398.

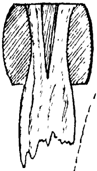


Fig. 399.

Fig. 400.

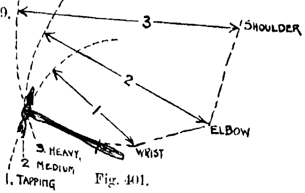


Fig. 401.

Lesson on Hammers.

Parts.—(*a*) Head made of cast steel, tempered on ends.
(*b*) Shaft of ash or hickory.
(*c*) Wedges of hardwood or iron.

Types of Heads.—Fig. 398 (*a*) Warrington hammer, (*b*) Exete hammer, (*c*) thin pane for setting plane irons, (*d*) ball-paned hammer for rivetting, (*e*) American adze-eyed hammer.

The hole through the head is termed the "eye"—narrowest at the middle. Wedges spread the top of the shaft (Fig. 399) and keep the head firmly fixed. Fig. 400, iron wedge.

Method of Using the Hammer.—Grip the handle about two-thirds of the length from the head. Three kinds of strokes Fig. 401:—(1) Tapping, from wrist. (2) Striking, using fore-arm and elbow. (3) Swinging blow, using the full arm.

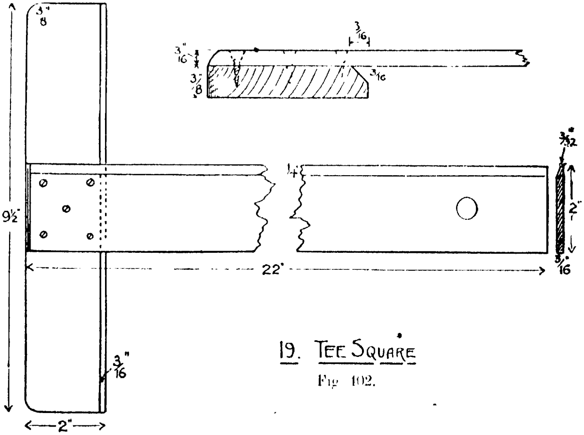


Fig. 402.

MODEL 19. **Tee Square.**

Drawing.—Plan Scale ½ (broken). Part Elevation. Scale 1. (Fig. 402.)

Bench Notes.

Rough wood: 10 in. × 2¼ in. × ½ in. } Mahogany.
22½ in. × 2½ in. × ¼ in. }

1. Plane up wood for stock 2 in. × ⅜ in.

2. Bevel edge. Saw to length and round corners.

3. Plane up blade to 2 in. × $\frac{3}{16}$ in. Plane edge and bevel with trying plane. Use a piece of $\frac{3}{4}$ in. wood to stiffen the blade whilst planing. Saw to length and bore holes.

4. Fix centre screw and test for right angle. Fix remaining screws. Do not glue, the blade should be detachable for truing.

N.B.—Particular care must be taken to obtain a straight ruling edge and a right angle between stock and blade.

Lesson on Glue.—Glue is prepared by boiling and treating horns, hoofs, hides, and animal offal. Sold in rectangular cakes about $\frac{1}{4}$ in. thick.

Tests of Glue in the Cake.

1. Brilliancy.
2. Absence of black spots and streaks.
3. Rub wet finger on cake. Should be sticky, not greasy.
4. Brittleness and hardness.
5. Does not dissolve out in cold water.
6. Should have very little smell.

Kinds of Glue.

1. Scotch glue, very strong, dark brown colour.
2. French glue, clear and semi-transparent, rich amber colour; more brittle than Scotch. Makes a "finer" joint, but is not so strong.

Preparation of Glue.

1. Break the cake into small pieces in a rag or paper.

2. Place in inner vessel of glue-pot and fill with cold water. Allow some time for the glue to swell.

3. Pour off the surplus water. Half fill the outside vessel and boil till glue is melted.

4. Remove any scum.

5. Glue should be used boiling hot, and should run off the brush like raw linseed oil. If thick and lumpy add more water and boil longer. If too thin boil off some of the water till of right consistency.

6. Take out the brush when work is finished.

Reheating.

1. Remove all dust and grit.

2. Add a little water and reheat.

3. Reheating weakens the adhesive power of the glue.

4. Particular care should be taken to keep water in outer pot, or glue will be spoiled by burning.

Glue Pot (Fig. 403).—Section showing outer and inner pots.

Brushes.—Brush should be stiff in the bristle. Have two brushes, one large, one small. A brush may be made from a piece of rattan cane by removing about 1 in. of the skin at the end and beating out the fibres with a hammer.

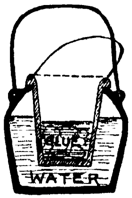


Fig. 403.

Making a Glued Edge-Joint.

1. Have the two surfaces true, *i. e.* straight, square, and out of winding.

2. Glue should be boiling.

3. Warm edges of boards, and apply glue evenly on both edges.

4. Put edges together quickly and rub together, squeezing out the glue.

5. Allow sufficient time to thoroughly set.

MODEL 20. **Table Mat.**

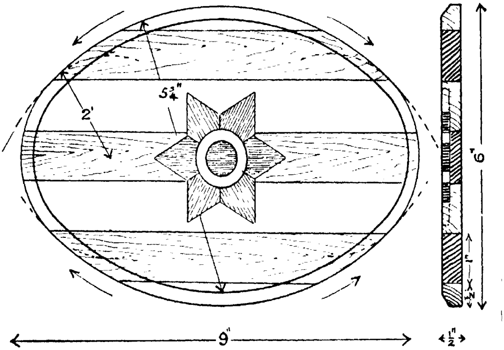
Drawing.—Plan and Section. (Fig. 404.)

Axes 9 in. and 6 in. Arcs for ends 2 in. radius, for sides $5\frac{3}{4}$ in. Centre inlay, hexagonal star in 3 in. circle. Scale $\frac{1}{2}$.

Bench Notes.

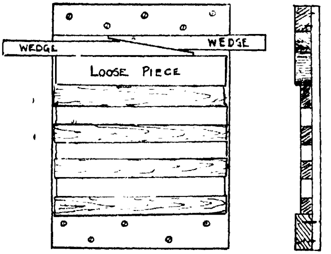
Rough wood: $9\frac{1}{4}$ in. × 4 in. × $\frac{3}{4}$ in. Mahogany.
$9\frac{1}{4}$ in. × 4 in. × $\frac{3}{4}$ in. Sycamore.
Walnut and sycamore for star.

1. Saw out and plane up strips of mahogany and sycamore (face and width)—take particular care with edges.



20 INLAID TABLE MAT.

Fig. 104.



CLAMPING BOARD for MODEL 20

Fig. 405.

2. Glue strips together and fix in clamping board (Fig. 405).

3. When set, plane nearly to thickness—set out ellipse. Saw out with bow saw. Finish with spokeshave, working in direction of arrows (Fig. 404).

4. Set out hexagonal star. Bore to depth with Forstner bit and finish with chisel.

5. Cut diamond shapes in walnut to fit—glue in position.

6. Bore large circle and fit circle of sycamore. Bore small hole and fit circle of walnut.

7. Finish with smoothing plane and glass paper.

8. Polish with linseed oil.

Lesson on Felling.—Specimens showing Hardwood and Sapwood. Section of trunk showing decay at centre.

Trees should be felled when they reach maturity, and when they contain least active sap. Whether maturity is reached or not is judged by the foliage and the size of the tree. Dead branches near the summit often indicate that maturity has passed. The oak takes from 60 to 100 years to mature, pines are generally cut between 70 and 80 years. If cut before maturity the timber contains an excessive amount of sapwood, and so is less valuable. After maturity the wood becomes brittle and unyielding, and begins to decay at the middle.

Felling usually takes place in late autumn and in winter, when the sap is practically dormant. If felled when full of sap, the wood is more apt to decay, and is more subject to the ravages of insects. It also takes a longer time in seasoning. When felled, the tree is stripped of all its branches, and the bark is chipped off with an adze till it is roughly square in section. In this state it is called a "log."

MODEL 21. **Paper Knife.**

Drawing.—Plan and Elevation, and Sections. Scale $\frac{1}{2}$. (Fig. 406.)

Bench Notes.—Rough wood: $12\frac{1}{2}$ in. × $1\frac{1}{2}$ in. × $\frac{3}{8}$ in. Sycamore.

1. Plane to width and thickness. Set out lines shown in elevation.

2. Shape handle with scribing gouge, paring chisel, and file.

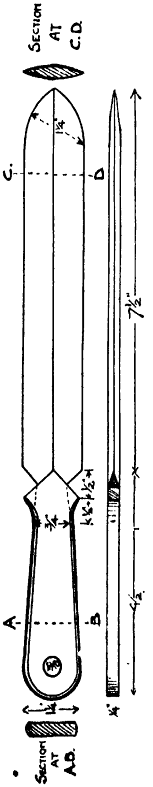


Fig 406. 21 Paper Knife

3. Cut notches with paring chisel.

4. Shape blade with spokeshave, paring chisel, and file.

5. Bore hole in handle. Finish off with fine glass paper (N.B — The edges should be straight and sharp.)

Lesson on Seasoning.—Timber when felled is unfit for immediate use; it requires seasoning to rid it of moisture and sap. Proper seasoning adds to the strength of the wood.

Methods of Seasoning.

A—*Natural Seasoning.*

1. *Dry Seasoning.* Timber stacked and allowed free circulation of air round each piece; must be protected from sun and wind, or it will crack and warp. Timber newly felled contains about 50 per cent. by weight of water. Half of this evaporates in the first few months of natural seasoning. Sawn into planks and stacked in the open, the water will be further reduced to about 12 or 15 per cent. of the total weight which is its normal condition out of doors. Indoors it may be reduced to 8 or 10 per cent.
2. *Water Seasoning.*—Logs immersed in running water, which washes out the sap. Timber then stacked and dried.

B—*Artificial Seasoning.*

1. Hot air: timber dried in ovens.
2. Steaming: steam is forced through the pores at high pressure. Sap is practically boiled out.
3. Burying the logs in hot sand.

Artificial seasoning is resorted to as a time-saving process. Dried timber is inferior to naturally seasoned timber. It is lighter, loses some of its nature, loses its brightness, is less durable and less elastic.

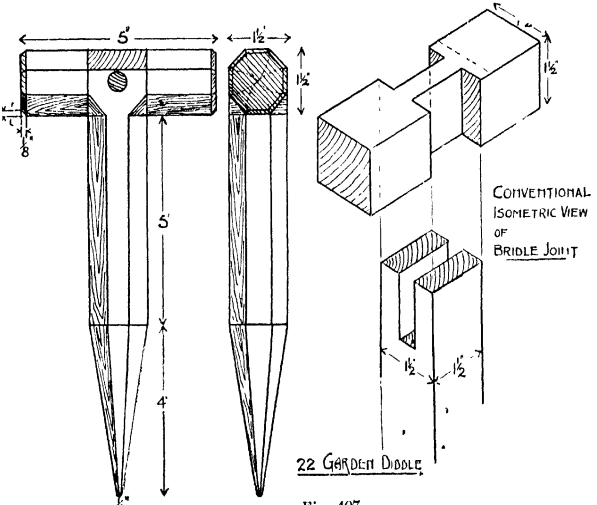


Fig. 407.

MODEL 22. **Garden Dibble.**

Drawing.—Front and Side Elevations. Conventional Isometric view of Bridle Joint. Scale ½. (Fig. 407.)

Bench Notes.—Rough wood: 16 in. × 1¾ in. × 1¾ in. Redwood.

1. Plane up wood to $1\frac{1}{2}$ in. square. Saw off piece for handle.

2. Set out lines for joint. Cut out notches in handle as in previous exercises.

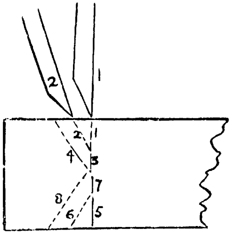


Fig. 408.

3. Saw down sides of notch in shaft and mortise out waste material with chisel and mallet, first stroke vertical, second oblique. Repeat as shown in Fig. 408. Test bottom of mortise with square—avoid a hump in the middle.

4. Fit the joint and bore hole for pin. Plane off top bevels on handle—separate the shaft and handle and plane bevels on underside. Chamfer ends of handle with chisel.

5. Chamfer sides of shaft with smoothing plane and chisel.

6. Point end to octagonal pyramid with chisel. (First, square pyramid, then take off corners.)

7. Glue handle on to shaft. Cut and file a round pin and glue in position. Cut off flush and finish with glass paper.

Lesson on Shrinkage.—Extraction of moisture during seasoning causes the wood to shrink. Greater shrinkage in sapwood than in hardwood.

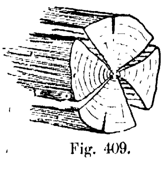


Fig. 409.

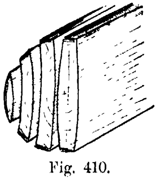


Fig. 410.

Contraction is least along the length of the medullary rays. The diameter is not reduced to any appreciable extent. Contraction takes place between the medullary rays at right angles to them, and so causes them to close together like the ribs of a fan.

Sections of newly felled wood should be kept in a dry place in the workshop, and the effects of seasoning noted—weight, thickness, circumference, diameter; measurements taken at stated periods and tabulated. Fig. 409 shows the effect of shrinkage in the log. Fig. 410 the effect on the boards cut out of the log.

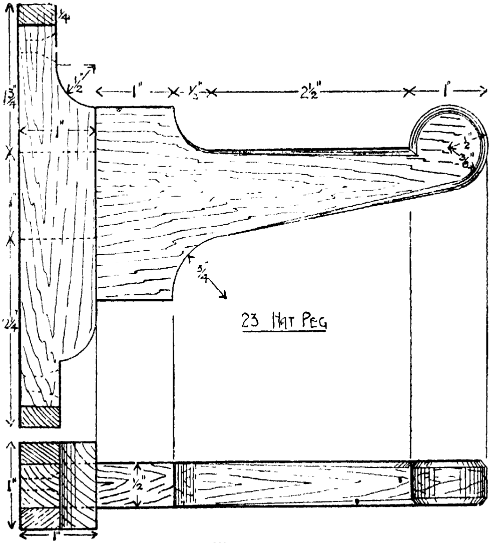


Fig. 411.

MODEL 23. **Hat Peg.**

Drawing.—Plan and Elevation. (Fig. 411.)

Bench Notes.—Rough wood : 5½ in. × 1¼ in. × 1¼ in. Oak.
6½ in. × 2½ in. × ¾ in. Oak.

1. Plane up back piece to 1 in. × 1 in., peg to 2¼ in. × ½ in.

2. Set out lines for mortise and tenon joint. Lines for mortise should be marked on both sides, using gauge and try-square.

3. Cut out mortise with ½ in. mortising chisel. (Fig. 412.)

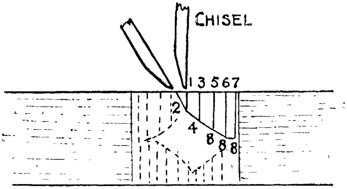


Fig. 412.

4. Saw out tenon.

5. Shape back and peg with incannelled gouge and paring chisel. Bore holes for screws.

6. Round off edges of peg with chisel and file.

7. Glue tenon in mortise.

8. Finish off with glass paper.

Lesson on Defects in Timber.—Shakes and knots due to growth. Cracks during seasoning. Fig. 413 shows simple heart shake. If in the same plane throughout the log, not very serious defect. Centre plank only affected. If twisted it reduces the value of the log considerably, as every board is cracked in consequence.

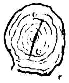


Fig. 413.

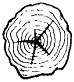


Fig. 414.

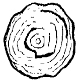


Fig. 415.

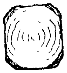


Fig. 416.

Fig. 414 shows a star-shake, cracks radiating from the centre.

Fig. 415 shows a ring or cup shake—due to various causes during growth—excessive wind pressure—sudden shock, such as fall in felling or a landslip, or effect of frost during winter.

Fig. 416 shows the "waney edges" or sapwood on a log.

MODEL 24. **Folding Towel Rail.**

Drawing.—Plan and Elevation. Scale ½. (Fig. 417.)

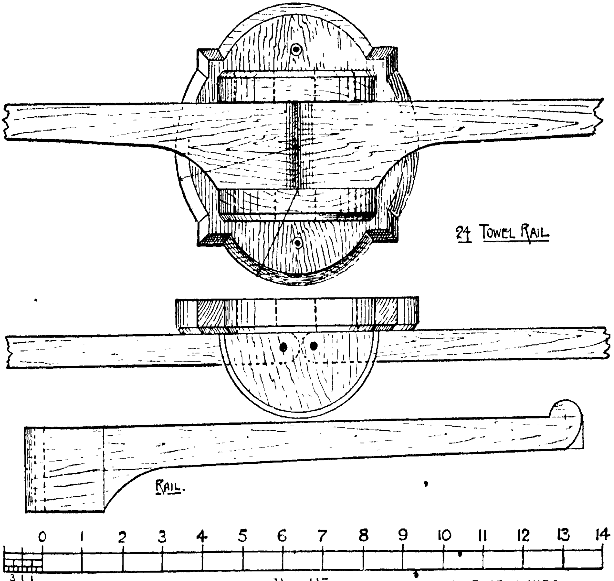


Fig. 417.

Bench Notes.

Rough wood:	Rails	15 in. × 4½ in. × 1 in.	Sycamore
	Back	7 in. × 6½ in. × 1 in.	
	Brackets	6 in. × 4½ in. × 1 in.	

1. Plane up back piece to thickness and set out mortises.

2. Plane up piece for brackets, saw into two and set out tenons.

3. Cut mortises (a $\frac{5}{8}$ in. hole bored through each will lessen the work of mortising the hole).

4. Saw tenons on brackets and mortise out piece between tenons.

5. Shape back and brackets.

6. Plain up rails and saw to shape with bow-saw, finish with spokeshave. Pare and file bracket end of rails to semicircles. Bore holes for pins (bore from each side) and holes for screws in back.

7. Bore holes in brackets for pins, holes in lower bracket bored only half-way through.

8. Glue brackets in position and fix rails with pins.

NOTE.—The drawing shows rail with semicircular bit glued on at end, if worked out of the solid allow 15 in. by 5 in. by 1 in. for rails.

Lesson on Oilstones.—Oilstone acts like a fine file and wears away the portion of the tool rubbed on it.

Stones have varying grits: coarse grit stones cut quickly but do not give a keen edge; fine grit stones cut slowly but give a fine, keen edge.

Used dry, the pores of the stone would soon become clogged with particles of metal and would cease to act. To float the particles and keep the pores free, a lubricant is necessary, either water or oil according to the stone used.

Kinds of Stone.

1. *Washita.*—American stone, even grain, yellowish-grey colour. Wears quickly, but cuts quickly.

2. *Arkansas.*—Cuts quickly, wears evenly; produces a fine keen edge. Rather expensive. Specially used for surgical instruments.

3. *Turkey Stone.*—Bluish tint, sometimes has white spots. Gives a keen fine edge but wears unevenly; slow cutting, very brittle, easily broken.

4. *Charnley Forest.*—Greenish-slate colour, sometimes small red and brown spots. Produces a fine keen edge, generally very hard; requires a lot of rubbing.

5. *Carborundum.*—Artificial stone made in a variety of grits. When caked with oil may be burned in the fire to free it.

Oil for Stones.—Best oil, either neat's foot or sperm. Sweet oil with one-eighth of paraffin added makes a good lubricant if wiped off after use. Petroleum and paraffin tend to harden the stone. Vegetable oils, *e.g.* linseed oil, should not be used, as they clog the pores and make the surface glossy and useless.

Casing.—The stone should be kept in a case. A suitable cement for fixing the stone is made by mixing glue and powdered red-lead into a paste.

The box should have rubber feet or pins in the bottom, to keep it firmly in position on the bench when in use.

Cleaning the Stone.—After use the stone should be wiped and the lid put on to keep off dust and grit flying about in the workshop.

Oilstone slips are small pieces of oilstone cut to shapes suitable for sharpening gouges, carving tools, bits, etc.

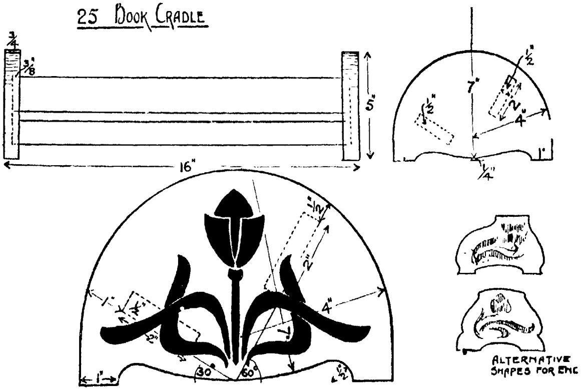


Fig. 418.

MODEL 25. **Book Cradle.** (Fig. 418.)

Drawing.—Front and Side Elevations. Scale ¼.

Half size elevation of end. The end may be treated in a variety of ways and designs should be made by the pupils themselves.

Bench Notes.

Rough wood: For ends 17 in. × $5\frac{1}{2}$ in. × 1 in. } Basswood.
For rails 16 in. × 5 in. × $\frac{5}{8}$ in. }

1. Plane up wood for ends and for rails.
2. Saw piece for ends into two. Plane edge for foot and set out design and position of sockets on inside.
3. Mortise out sockets, first boring $\frac{1}{2}$ in. holes $\frac{3}{8}$ in. deep to remove some of the wood.
4. Saw ends to shape with bow saw. Finish with spokeshave.
5. The design on the end may be worked in a variety of ways. (1) Punching with matting punch. (2) Cut out with veining chisel. (3) Poker work. (4) Stencilling. (5) Wax inlaying. In wax inlaying the design is first cut out with a V tool and gouges and, after a coat of shellac varnish, is filled with a composition of wax, resin, and powder colour.

Lesson on Oak.

Colour.—Brown, varies from light shades to dark.

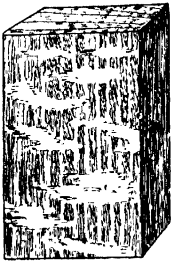


Fig. 419.

Annual Rings.—Very distinct, spring and autumn wood easily distinguished.

Medullary Rays.—Very clearly defined. The silver grain is got in wainscot oak by cutting the log along the line of the medullary ray. (Fig. 419.)

Grain.—Straight and even.

Characteristics.—Hard, tough, heavy, very strong, durable in any situation. When properly seasoned does not warp or twist much. Contains a pyroligneous acid which corrodes iron and causes decay of the wood in contact. Brass fittings and screws generally used. Copper also used.

Uses.—Shipbuilding, cabinet making, carving, building, carriage building, coopering.

The Tree (*Quercus Robur*).—Over 300 varieties. British oak exists in two varieties: (1) *Quercus robur penduncultata*;

(2) *Quercus robur sessiliflora.* Difference detected by observation of leaf, flower, and fruit. In No. 1, *Quercus R.P.*, the stalks of the female flower and acorn are long and the leaves are sessile. In 2, *Quercus R.S.*, they are reversed, long stalk to leaf and short stalk to acorns, which hang in clusters.

Gall Nuts, or oak apples, are caused by the gall-fly.

Oak Spangles, on the underside of the leaf, due to the same cause.

Oak tree has short trunk with large wide-spreading branches. Attains a height of 70-100 feet. In exposed situations the tree is generally shorter, with trunk and branches very gnarled.

Where found.—Middle and Southern Europe. North America and parts of South America.

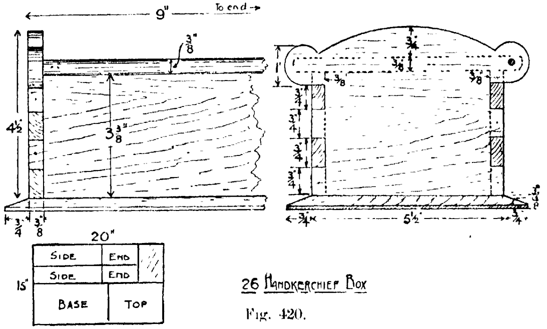


Fig. 420.

MODEL 26. **Handkerchief Box.**

Drawing.—End Elevation and part Front Elevation. Scale ½. (Fig. 420.)

Bench Notes.—Rough wood :

16½ in. × 7½ in. × ½ in. for sides and ends } Basswood
20 in. × 7½ in. × ½ in. for top and base }

1. Plane up wood to ⅜ in. thickness. Saw out pieces for sides, ends, base, and top.
2. Plane pieces to required thickness.
3. Draw shape of end pieces and work to shape.

4. Set out notches with gauge and square. Saw and chisel out notches. (Saw on waste side of line.)

5. Glue and nail joints (panel pins). Punch nail heads and finish joints smooth with smoothing plane and glass paper.

6. Square base, bevel edges (long edges first). Glue and nail in position.

7. Cut top to size. Round front and back edges with plane and glass paper. Bore hole (with pin bit) for nail hinge. Cut heads off wire nails and drive in to make hinge.

The broad surfaces offer a good opportunity for designs to be executed in poker work or in marquetrie staining. Avoid over elaboration of design.

Lesson on Beech.

Colour.—Light to reddish brown.

Annual Rings.—Indistinct.

Medullary Rays.—Very clear on cross section, appear as dark dots or flecks on tangential section.

Grain.—Fine and straight, close and even texture.

Characteristics.—Hard and heavy. Liable to warp. Contains an acid which corrodes iron. Takes a high polish and wears smooth by friction. Durable if kept continuously wet or dry. Rots soon if subjected to alternate wet and dry. Attacked by worms which bore holes in it.

Uses.—For all kinds of turnery, chair-making, tool handles, planes, French sabots.

The Tree (Fagus Sylvatica).—Large tree 60-70 ft. high, base circumference sometimes 12 feet. Large limbs and branches.

Bole.—Slaty-blue coloured bark, having smooth appearance.

Leaves.—Simple, ovate, indented, hairy on the margin. Light green silky appearance in spring, glossy dark green in summer, brown in winter. Hang on the tree for a long time during the winter.

Fruit.—Beech nut, single cell containing three kernels, called "mast"; used to be valued for feeding swine.

MODEL 27. **Alarm Clock Bracket.**

Drawing.—Plan, Side and Front Elevations. Scale $\frac{1}{2}$. Isometric view of joint (common dovetail). (Fig. 421.)

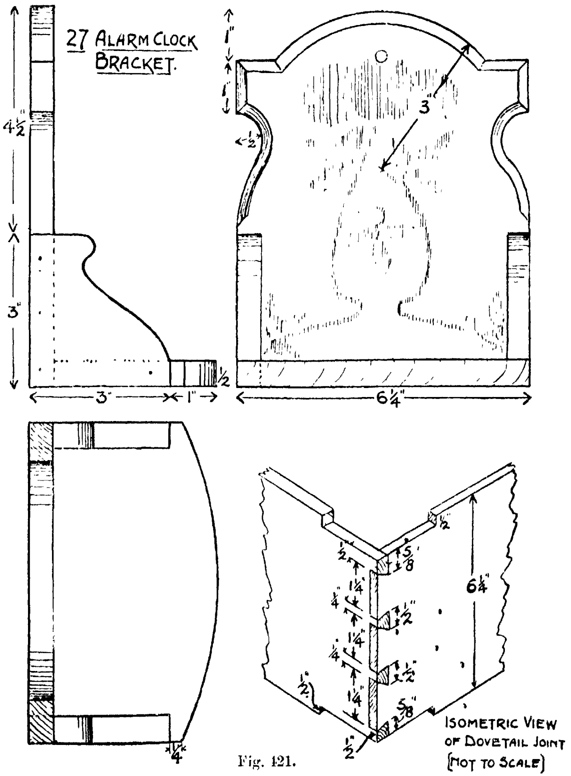

27 ALARM CLOCK BRACKET.
4½"
3"
3"
1"
½
1"
1"
½"
3"
6¼"
¼"
½"
½"
5/8"
¼"
1¼"
½"
¼"
1¼"
½"
½"
1¼"
5/8"
½"
6¼"
ISOMETRIC VIEW OF DOVETAIL JOINT (NOT TO SCALE)

Fig. 121.

Bench Notes.—Rough wood: 16 in. × 6¾ in. × ⅝ in. Basswood.

1. Plane up wood to ½ in. thickness.
2. Saw off pieces for back and base (one piece) and sides.
3. Plane up back and base to required width and saw apart.
4. Set out lines for pins on back piece and saw down sides of pins.
5. Waste between pins may be partly removed with the bow saw and finished with paring chisel, or may be mortised out as in previous exercises.
6. Mark sockets from pins (Fig. 422). Note that wide side of dovetail is inside.

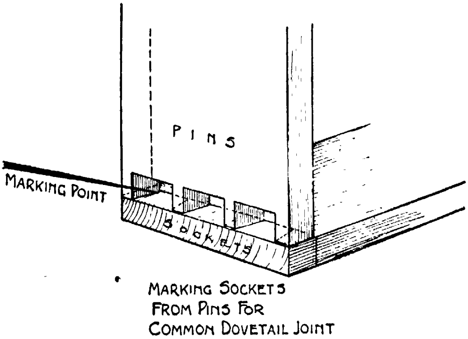


Fig. 422.

7. Saw down sides of sockets, mortise out middle sockets, saw out side sockets.
8. Shape back and base with bow saw, chisel, and file. The design shown may be stencilled on to the back or worked in poker work.
9. Cut notches at sides and glue joint in position.
10. Saw out and finish side pieces. Glue and nail in position.
11. Smooth off dovetail joint with smoothing plane.

Lesson on Elm.

Colour.—Reddish-brown colour.

Annual Rings.—Very distinct. Sapwood lighter colour than heartwood.

Medullary Rays.—Extremely fine and numerous.

Grain.—Twisted and not very regular.

Characteristics.—Peculiar fetid odour when green. Heavy, hard, strong, and tough. Lasts well under water.

Uses.—Engineering work, ship building, wheelright work and rural carpentry.

The Tree (*Ulmus*).—Two varieties well known. (1) *Ulmus Montana:* Mountain, Scotch or wych elm. (2) *Ulmus Campestris:* English elm. Large spreading tree, tall stem, fine appearance in winter.

Leaves.—Simple, ovate, doubly serrated on margin, rough to the touch on top. Veins strongly marked. Leaves appear early and hang late.

Flowers.—Appear before the leaves (March or April).

Fruit.—An oblong samara about 1 in long. Single seed in middle of a light membranous wing. Seed of *Ulmus Campestris* not produced in this country. Tree propagated by suckers which shoot up all round the base of the tree.

Where Found.—Middle Europe, parts of America, and West Asia.

MODEL 28. **Tea Tray.**

Drawing.—Plan and End Elevation. Scale $\frac{1}{4}$. End and front elevations of corner. Full size. (Fig. 423.)

Bench Notes.—Rough wood:

$$\left.\begin{array}{l}\text{For base } 17 \text{ in.} \times 13 \text{ in.} \times \frac{5}{8} \text{ in.}\\ \text{For sides } 16\frac{1}{2} \text{ in.} \times 3 \text{ in.} \times \frac{5}{8} \text{ in.}\\ \text{For ends } 12\frac{1}{2} \text{ in} \times 4\frac{1}{2} \text{ in.} \times \frac{5}{8} \text{ in.}\end{array}\right\} \text{Basswood.}$$

1. Plane up wood to $\frac{1}{2}$ in. thickness.
2. Plane up sides to $1\frac{1}{4}$ in. and ends 2 in. width.
3. Set out pins on either side and cut out.
4. Set out sockets on ends, making each set to correspond with pins for same corner. Cut out sockets.

5. Shape handles with bow saw and spokeshave.

6. Bore holes for handle, shape with gouge, chisel, and file.

7. Glue joints, and when dry and set, finish off with smoothing plane.

8. Plane edges of base to shape shown.

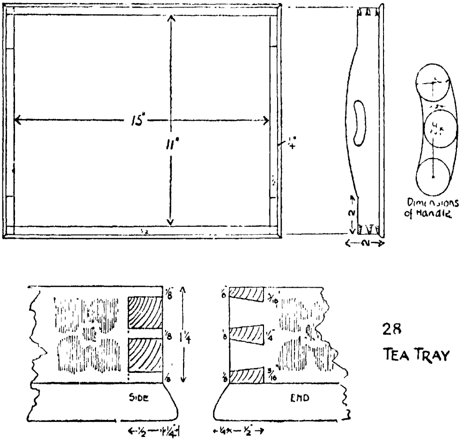


Fig. 423.

9. Glue base in position and fix with countersunk screws.

The base offers a good opportunity for simple inlay or flat relief carving. The sides also may be decorated with simple designs at the corners and in the middle.

Lesson on Ash.

Colour.—Pinkish white or light brown.

Annual Rings.—Distinct, spring wood very porous. In young trees sapwood and heartwood same colour. In older trees heartwood shows a tinge of reddish-brown.

Grain.—Sometimes coarse and twisty ; often beautifully marked.

Characteristics.—Tough, elastic, and strong. Heavier than redwood. Stands sudden strains. Sapwood as valuable as heartwood.

Uses.—Tool handles, wheels (felloes and spokes) agricultural implements, gymnastic apparatus. Hungarian ash cut into veneers, beautiful wavy grain.

Tree (*Fraxinus excelsior*).—Light and graceful, 30 to 50 ft. high. Bark, light grey. Buds, very black.

Leaves.—Compound, pinnate, 7 to 11 leaflets, serrated on the edges.

Flowers appear before the leaves. *Fruit,* "keys," seed at the base of a flat twisted wing, which gives it a whirling flight when falling.

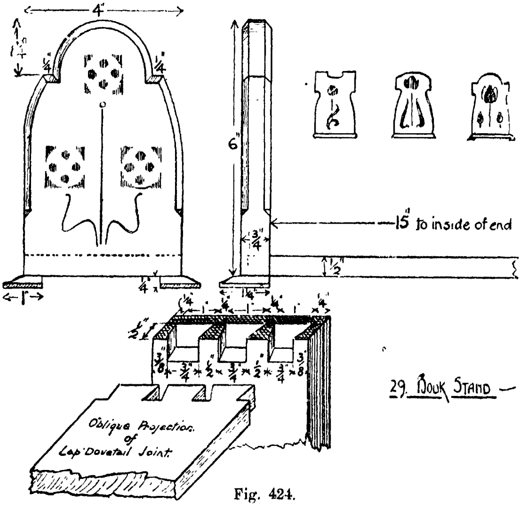


Fig. 424.

The shade and drip of the ash retard growth of vegetation round it.

Where found.—Over Europe, North America, and Northern Asia.

MODEL 29. **Book Stand.**

Drawing.—End Elevation and Part Front Elevation. Scale $\frac{1}{2}$. Oblique projection of Lap Dovetail Joint. (Fig. 424.)

Bench Notes.—Rough wood:

For ends 13 in. × $4\frac{1}{2}$ in × $\frac{7}{8}$ in.
For base and feet $18\frac{1}{2}$ in. × $4\frac{1}{2}$ in. × $\frac{5}{8}$ in. } Sycamore.

1. Plane up wood to width and thickness.

2. Set out lines on end pieces. Saw off and square end for foot.

3. On base piece gauge line $\frac{1}{2}$ in. from each end. Set out lines for sockets and saw with dovetail saw on waste side of lines. Remove waste with chisel and saw.

4. Gauge $\frac{1}{2}$ in. lines on base of end pieces for pins. Mark pins from sockets, using a fine marking point. (Fig. 425.)

5. Saw as much of pins as possible and finish by mortising out the waste. (Fig. 426.)

6. Shape ends with bow saw and chisel. Work design in inlay. First fit mahogany squares 1 in. side. Bore hole $\frac{7}{8}$ in. and fit circular piece of light coloured wood, *e.g.* basswood, birch, or ash. Bore holes for small circles. A lead pencil makes quite a satisfactory inlay. Small pieces are cut off the pencil, the lead is removed, and the hole plugged with a round wooden vesta. Keep the sections of the pencil in the same direction. The stalks should be cut with a **V** tool and inlaid with wax; or if cut carefully, a piece of walnut veneer may be soaked and softened and then fitted in edgewise.

7. Clean off the inlay with smoothing plane and fine glass paper, and glue the joint.

8. Cut and shape feet and glue in position. (As an alternative a piece of moulding may be run and fitted round the edge, mitring the corners.)

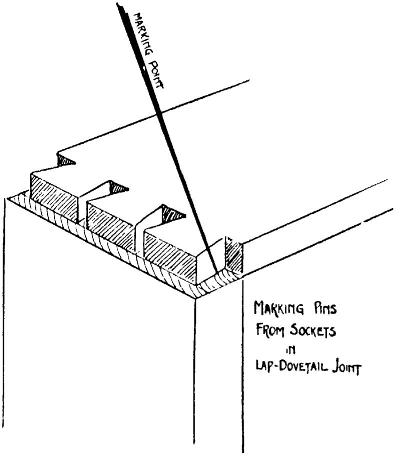


Fig. 425.

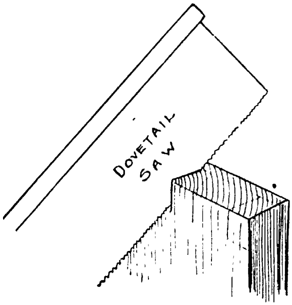


Fig. 426.

Lesson on Sycamore.

Colour.—Almost white.

Medullary Rays.—Very fine.

Annual Rings.—Hardly seen.

Grain.—Close, compact, easily worked; takes a fine polish. Has a small silver grain when cut along the line of the medullary ray.

Characteristics.—Brittle and stiff, free from knots or shakes; not liable to splinter; shrinks a lot in seasoning; does not warp under influence of alternate heat and moisture

Uses.—Cabinet-making, musical instruments, turning, dairy utensils.

The Tree (Acer pseudo-platanus).—Not a native; introduced in fifteenth century. Often mistaken for the Plane tree. Quick growing; height 60-80 feet in 50 to 60 years. Allied to the maple.

Leaves.—Palmate, five-lobed, 6 in. to 8 in. across, serrated on the edges. Often exude sugary sap.

Fruit.—Hangs in clusters, two seeds at the base of a pair of wings.

Where found.—Britain, Eastern Europe, Germany and America.

MODEL 30. Newspaper Rack.

Drawing.—Front and Side Elevations.
Oblique projection of end of bottom rail. (Fig.427.)

Bench Notes.

Rough wood: For frame, 13 in. × 5 in. × $\frac{1}{8}$ in. Basswood.
For rails, 6 in. × $3\frac{1}{2}$ in. × $\frac{1}{2}$ in. Basswood.
For arms, $6\frac{1}{2}$ in. × 5 in. × $\frac{3}{8}$ in. Walnut.

1. Plane up wood for frame to thickness. Saw up and plane to width.

2. Set out lines for mortise and tenon joints and cut as in previous exercise, Model 23.

3. Set bevel stock to 60°, and set out front face of bottom rail. Plane off.

4. Plane up wood for rails: mortise out sockets for rails. Bore holes for thistle pattern and cut out with pad saw.

5 Plane up wood for arms Shape to design with saw and chisel. Lines on thistle head cut with V tool.

6. Fix rails in position, and glue mortise and tenon joints. Finish off with smoothing plane.

7. Glue arms in position and fix with round-head screws.

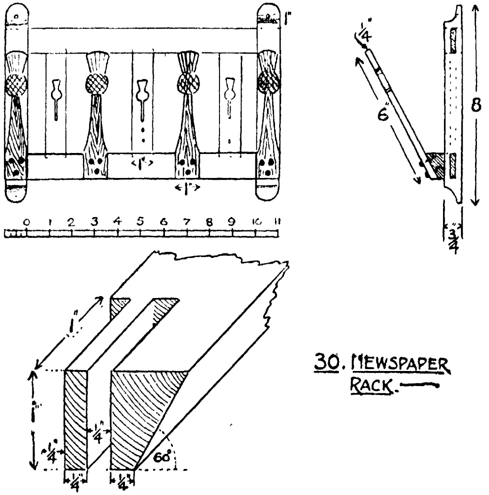


Fig. 427.

Lesson on Walnut.

Colour.—Brown, with dark graining.
Annual Rings.—Fairly distinct.
Medullary Rays.—Very fine and numerous

Grain.—Beautiful markings, easily worked; uniform texture; takes a fine polish.

Characteristics.—Flexible but not strong; does not split readily. Sapwood light in colour; does not corrode metal fastenings. Warps little after seasoning,

The Tree (*Juglans Regia*: "*Juglans*" from "*Jovis glans*," the nuts of Jupiter).—Native of the Himalayas and Asia Minor. Introduced into Britain about fifteenth century. Grows to height of 40 to 60 feet with bole of 20 feet circumference. Large spreading head. Bark, smooth grey when young. Becomes rugged and furrowed in the old tree.

Leaf.—Compound; five leaflets. Resembles the ash, edge not serrated.

Fruit.—Walnut, containing edible kernel. Fine oil obtained from kernel; dye obtained from husks.

Where Found.—Persia, Asia Minor, Spain, Italy, France, and Great Britain.

DIRECTOR OF INDUSTRIES
Bengal

CHAPTER VIII.

LIGHT WOODWORK

Light Woodwork.—This form of Handwork is adopted in some schools as an alternative to advanced cardboard modelling and the heavier type of woodwork. There is a great saving of expensive equipment, and it can be carried on in the ordinary classroom. As an alternative to heavy woodwork it falls short. It is very limited in its scope, and there is a lack of reality and utility about the objects made. It might, with advantage, be used as an introduction to ordinary woodwork, as the type of work is well fitted to the physical abilities of the pupils at this stage, and it will serve to give them a very valuable practical knowledge of the action of cutting tools on wood. It affords excellent opportunity of developing the constructive ability of the child, and, in conjunction with cardboard modelling, a number of interesting and attractive models can be made.

Strip Woodwork.—In this form of light woodwork the pupils work on strips of yellow pine of various sizes and sections, planed on the faces and having the edges fine sawn.

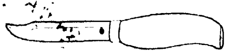


Fig 428.

Cutting the Strips.—Strips may be cut with the knife. An ordinary pocket-knife will serve, but a better form is the Sloyd knife in Fig. 428. This has a rigid blade, is firm in the back, and the handle affords a better grip than the ordinary pocket-knife.

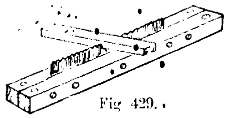


Fig 429.

Sawing—A simple sawing device is shown in Fig. 429. This is attached to the bench or desk, and the strip is rubbed on the teeth. If a saw is used, it should be a form of light dovetail saw, and the wood should be sawn on a bench hook (Fig. 430).

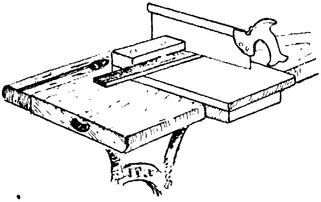


Fig. 430.

Marking.—For squaring, a small try-square is needed, or a 60° wooden set square with a strip glued on the edge can be used for most purposes (Fig. 431).

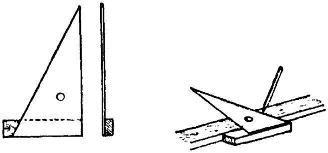


Fig. 431.

Jointing :—

1. *Nailing.*—The pieces are nailed together with fine panel pins and the point clinched over with the hammer. For a clinching block a broken flat iron will serve, or a large boot protector driven into the end of the bench (Fig. 430).

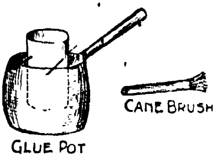


Fig. 432.

2. Gluing or fixing with seccotine may be used as a means of jointing. Fig. 432 shows a simple form of glue kettle made from an ordinary pan and a cocoa tin.

3. *Lapping.*—To make the joint, the ends of the wood are arranged to lap over each other and they are then fixed with nails or glue (Fig. 433). This is only useful in built-up models.

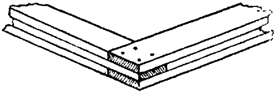


Fig. 433.

Boring.—For preparing holes for the nails, a fine bradawl is used. This must be used with the chisel edge *across the grain* (Fig 434).

For larger holes a gimlet (Fig. 435) or a small hand drill (Fig. 436) may be used.

Sandpaper. — Fine sandpaper should be glued to a flat piece of board and the edge to be cleaned should be rubbed on the board; care being taken not to rock the wood but to keep it quite steady.

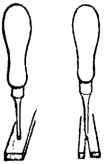


Fig. 434.

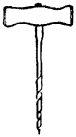


Fig. 435

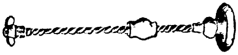


Fig. 436.

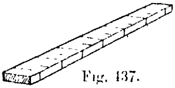


Fig. 437.

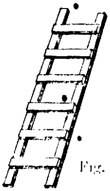


Fig. 438.

Types of Models in Strip Woodwork.

1. Ruler (Fig. 437).
2. Ladder (Fig. 438).

3. Gate (Fig. 439).
4. Pot Stand (Fig. 440).
5. Photo Frame (Fig. 441).

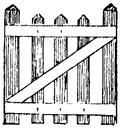


Fig 439

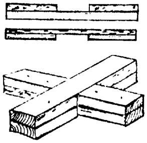


Fig. 440

6. Tooth Brush Rack (Fig. 442).
7. Sign Post (Fig. 443).
8. Railway Signal (Fig. 444).
9. Draining Stand (Fig. 445).
10. Photo Easel (Fig. 446).
11. Garden Seat (Fig. 447).
12. Doll's Swing (Fig. 448).

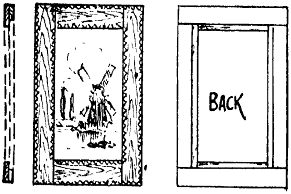


Fig. 441.

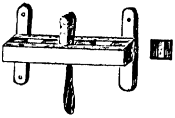


Fig. 442.

Sloyd Knife Work.—In this branch of Light Handwork the work is not confined to strips. The models are made out of thin sheets of yellow pine planed on the face and back. In supplying pieces for work, the teacher must *split off* lengths of suitable width, or the pupil will have difficulty in dressing up the edges. As far as possible the wood supplied should have the grain

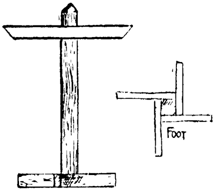


Fig. 443.

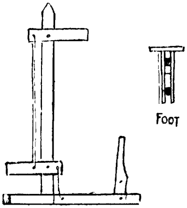


Fig. 444.

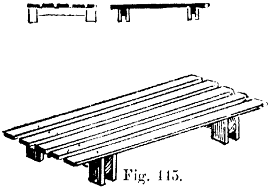


Fig. 445.

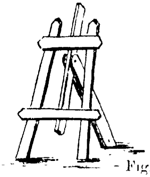


Fig. 446.

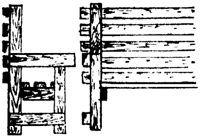


Fig. 447.

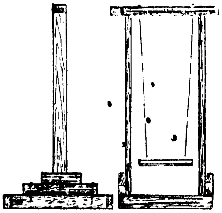


Fig. 448.

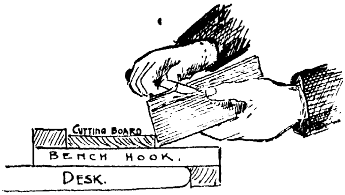


Fig. 449.

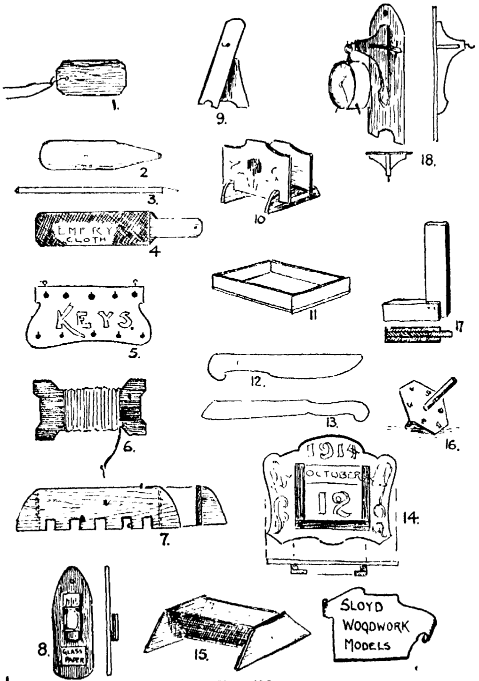


Fig. 450.

running along the length of the model parallel with the edges. The pupil should be supplied with a bench hook and cutting board and should be taught to cut the wood away from him, the edge of the wood resting in the cutting board. He should not be allowed to slash in the air, as it is a rather dangerous practice in a class-room where the pupils are close together. The wood should be held in the left hand and short cuts should be taken, commencing at the end farthest from the worker (Fig. 449).

Types of Models in Sloyd Knife Work. (Fig. 450.)

1. Key Label.
2. Plant Label.
3. Pot Stick.
4. Knife Strop. (Piece of emery cloth glued on.)
5. Key Rack, with screwed hooks.
6. String Winder
7. Marble Board. (Side elevation showing struts at back.)
8. Match-Box Holder. (Clip for match-box built up to required thickness.)
9. Watch Stand.
10. Letter Stand.
11. Tray.

12. and 13. Paper Knives.

14. Calendar Stand. (Case built up as shown in plan.)
15. Feeding Trough.
16. Teetotum.
17. Try Square.
18. Alarm Clock Bracket. (Plan and side elevations showing method of fixing.)

Rustic Woodwork.—Some very pretty models can be made by using the wood in its natural state with the bark on. This is more suitable for children in a rural school. Twigs and sections of branches are used, and nailing and tying with thin iron wire are used as the means of fastening.

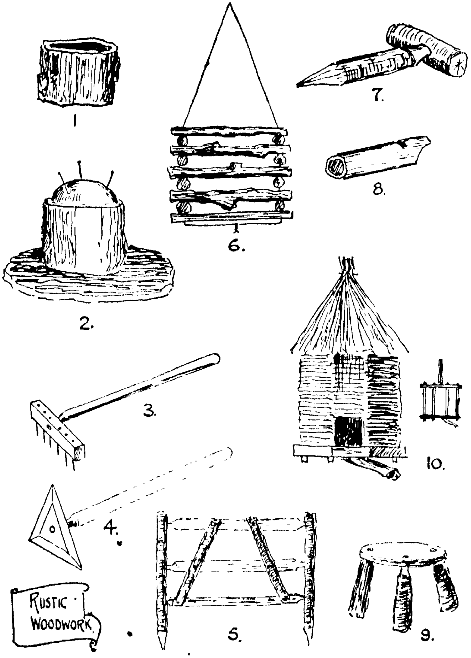


Fig. 451.

Types of Rustic Work. (Fig. 451.)

1. Serviette Ring—A hole is bored through the middle and the wood is pared away with the knife till only the thin bark remains.

2. Pincushion.

3. Rake.

4. Hoe.

5. Hurdle—The twigs are split along the length to form the rails.

6. Fern Basket.

7. Garden Dibble.

8. Whistle made from a piece of elder.

9. Milking Stool.

10. Bird House.—A skeleton framework is first made with boards top and bottom and is then woven with rushes or straw. The thatching is fastened to the centre post.

Toy Making.—Quite a number of interesting and instructive toys can be made with a very few tools. All sorts of material are called into use, and the work teaches a child to make the most of what he has.

Types of Toy Making. (Fig. 452.)

1. Wheel Barrow—Box of cardboard; wheel, boot polish tin; handles and feet, strip woodwork.

2. Table—Cardboard top, strip woodwork legs and frame.

3. Chair—Frame, strip woodwork; back and seat, cardboard.

4. Couch, 5. Crib—cardboard and strip woodwork.

6. Toy Engine—Boiler, tin canister; wheels, boot polish tins; funnel and buffers, half cotton reels; cabin and tender, tin biscuit boxes shaped with strong pair of scissors; wooden base.

7. Windmill—Vanes, feathers mounted on a piece of cork; beads to prevent friction; tail, cardboard.

8. Whirligig—Body, walnut shell; spindle, wooden skewer shaped at top; weight, potato.

9. Flying wheel—wood; the shaft is rubbed quickly between the palms and then released.

10. Snake—Cut out piece of tin or stout cardboard; rotates on a bent hair pin held over a lamp-chimney.

11. Scoop—Cut from a cocoa tin.

These models are not offered as a course of Handwork for the school, but as suggestions of exercises that the children might perform at home. The materials are easily procured and the tools are few.

Lessons on tools and materials should run concurrently with the lessons in Handwork, and the models should all be made to given dimensions.

For lessons on tools and materials *vide* Chap. VII.

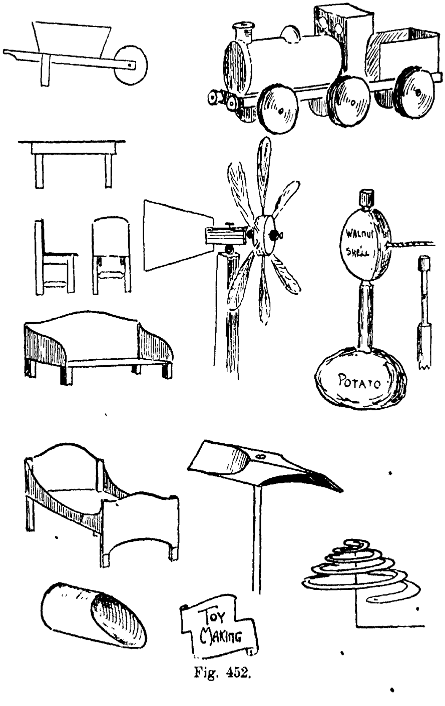


Fig. 452.

CHAPTER IX.

METAL WORK.

Metal Work.—As a form of Educational Handwork, metal work has much to commend it both for town and country school. There is something substantial and permanent about metal work which appeals to pupils, especially boys. The tool operations are legion and the varieties of media offer a wide choice. To a large extent, metal work has found a place in the school curriculum as a third and fourth year's course, following two years of woodwork. In this position it has not had a fair chance, as most of the pupils are at the leaving stage and few are able to get far with the work. Taken all over, too, the work is more expensive than woodwork, both for material and for equipment There is much in a metal work course that is excellent and well suited to the pupils of the elementary school, and if the work cannot be taken up as a distinct course, a very profitable combination of woodwork and metal work could be taken, without adding any very great cost either for material or for equipment. The subject may be studied under the following heads.—

1. Wire Work.
2. Strip-iron Work.
3. Tin-plate Work.
4. Heavy Iron Work and Sheet-metal Work.
5. Repoussé Metal Work.
6. Forging.
7. Turning and Machine Work.

The general method of teaching metal work is similar to that followed in woodwork, and concurrent lessons on materials, tools, and processes should be taken in conjunction with the practical work. Drawings should be made to scale before the work is executed, and the pupil should have opportunities of designing models for himself.

In drawing up a course of metal work models, selections should be made from each section so that the pupil becomes familiar with the various media and with the various methods of manipulating them.

Wire Work.

Material employed.—Galvanised iron wire 10 to 18 S.W.G. (Standard Wire Gauge). Brass and Copper wire.

Tools and Apparatus.

Bench.—Most of the wire work can be performed in the ordinary classroom; but for metal work generally, a heavy, rigid bench should be provided. A dual bench of dimensions similar to the one in the woodwork section (page 101) would serve quite well.

Vice—The ordinary woodworking vice is unsuitable and is too low. A Parallel Vice (Fig. 453) bolted on the top of the bench, should be fitted, and the height should be such that the top of the vice is level with the pupil's elbow when the forearm is raised. An average height will be about 40 in. above the ground.

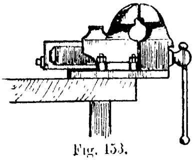


Fig. 453.

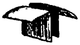


Fig. 454.

Where combined woodwork and metal work are carried on in the same workshop, it is a good plan to fix the vice to a heavy block of pitch pine. This block is held in the woodworking vice, and when not required is easily removed.

Vice Clamps.—These can be made by the pupils themselves. They consist of pieces of brass, copper, or lead, bent over (Fig. 454), to prevent the file-like face of the jaws from damaging delicate or finished work.

Pliers.—For working the wire, round-nosed (Fig. 455), flat-nosed (Fig. 456), and cutting pliers (Figs. 457 and 458) will be required.

If the wire is too heavy to cut with the wire cutters, it may be cut with a hammer and cold chisel (Fig. 459) or with a hack saw (Fig. 460). The ordinary hack saw blade is very hard and brittle and requires very great care in the use of it Blades having a double cutting edge and soft centres are a great convenience and a saving in upkeep.

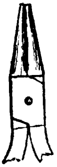


Fig 455.

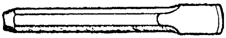


Fig. 459.

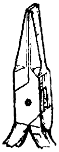


Fig. 456.

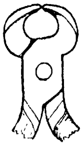


Fig. 457.

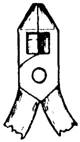


Fig. 458.

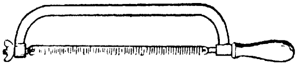


Fig. 460.

Files. Half-round and flat (with safe edge) should be provided in coarse, bastard, and smooth cuts.

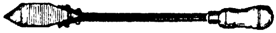


Fig 461.

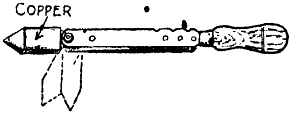


Fig. 462.

Soldering Apparatus.—Copper bit, soldering bolt or soldering iron (Fig. 461). This consists of a piece of copper weighing about 8 oz., riveted to an iron shaft fitted into a wooden handle. Fig. 462 shows an improved form which admits of the head being placed in different positions as required. To heat the iron, access is needed to a fire or gas ring. Special gas stoves with covers are made for the purpose.

Solder (*soft*).—This is an alloy of two parts of tin to one part lead, and for class work should be provided in narrow strips about ¼ in. wide. There are several kinds of soft solder according to the work they are intended for, but the above solder will be found suitable for tin-plate work and for jointing the wire.

Flux. Killed Spirit.—This is made by adding scrap zinc to hydrochloric acid till the bubbling ceases. After a time the liquid is decanted and is used for soldering. With brass or copper a better flux is Fluxite (a patent preparation in the form of a paste), as killed spirit is liable to corrode these metals unless they are properly cleaned after soldering.

Tinning the Iron.—An old file and a block of sal ammoniac should be provided for tinning the iron.

Mandrels.—These consist of pieces of iron of various sections used in the shaping of the wire, and are made from any odd pieces suitable.

Types of Models in Wire Work. (Fig. 463.)

	Name.	Gauge. S.W.G	Material used.
1.	Wire Staple	10	Galvanised Iron Wire
2.	Ring	10	Galvanised Iron Wire, soldered
3.	Skewer	12	,, ,, ,,
4.	Meat Hook	9	,, ,, ,,
5.	Cabin Hook	10	,, ,, ,,
6.	Hook	10	,, ,, ,,
7.	Drawer Handle	10	Hard Brass Wire
8.	Photo Stand	10	,, ,,
9.	Spiral Puzzle	14	Galvanised Iron Wire, soldered
10 & 11.	Chains	18	,, ,, ,,
12 & 13.	,,	18	Hard Brass Wire
14.	Chain	18	Copper Wire
15.	,,	18	Copper Wire and glass beads held in position by small beads of solder
16.	Toasting Fork	10	Galvanised Iron Wire, soldered
17.	Egg Switch	10	,, ,, ,,
18.	Egg Lifter	10	,, ,, ,,
19.	Pipe Rack	14	Hard Brass Wire
20.	Frame for Lamp Shade	10 14	for top and bottom rings } Gal. Iron for stays and hooks } Wire

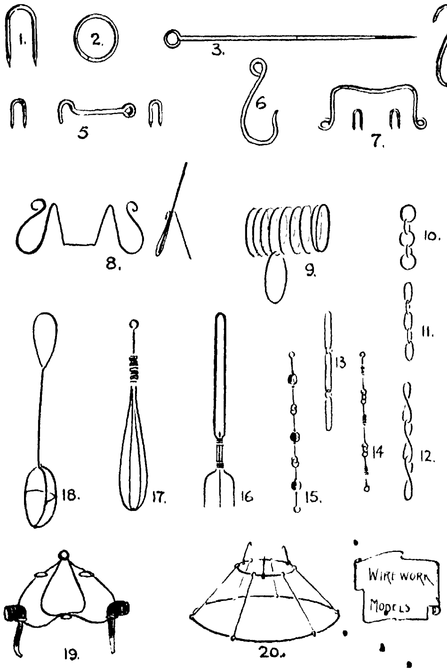


Fig. 463.

Strip-Iron Work.—The material used is for the most part sheet iron in strips, about 20 gauge, $\frac{3}{8}$ in., $\frac{3}{16}$ in., and $\frac{1}{8}$ in. wide. The $\frac{3}{8}$ in. strips are used for framing, the $\frac{3}{16}$ in. for decorative details, and the $\frac{1}{8}$ in. strips for ties for binding the parts together. The strips can be procured ready cut or may be cut from the sheet with a pair of snips (Fig. 464). Round-nosed and flat pliers are used for bending the iron and for fastening the clips. Holes for rivets may be punched through the strips by

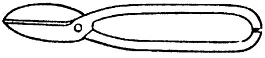


Fig. 464.

means of steel punches. The punches are hard on the point and the strip of metal is placed on the end grain of a piece of wood for support, whilst the punch is driven through with a heavy hammer. Fig. 465 shows another method. Piece A consists of a piece of bar steel slit at the end wide enough to take the strip. The punch is driven through a hole drilled right through the bar. This gives a much better finish than the hardwood block.

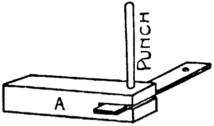


Fig. 465

Riveting.—There are two kinds of rivets, Snap-head (Fig. 466A) and Countersunk (Fig. 466B). Snap-headed rivets are best for thin metal, because there is no need to countersink the hole, which would weaken the metal at that place and would probably not be deep enough.

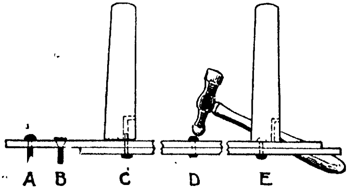


Fig. 466.

The rivet should be of suitable length, and when inserted the shank should project about one and a half times its diameter. The Rivet Set is taken and the deep hole placed over the shank of the rivet (Fig. 466c). A sharp blow with the hammer drives the parts together. The shank is then riveted over with the ball pane of a riveting hammer (Fig. 466D) and finished off with the shallow hemispherical hole in the Rivet Set (Fig. 466E).

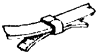


Fig. 467.

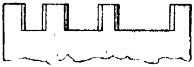


Fig. 468.

Ties.—Fig. 467 shows how the strips of $\frac{1}{8}$ in. iron are used to bind pieces of the work together. The ends should be placed on the side where they are least conspicuous.

Various devices are made for bending scrolls, but the less they are used the more hand and eye training there will be. Fig. 468 shows a slotted plate used for scroll work. The wide gaps give curves of large radius, and the narrow gaps small curves.

Examples of Strip Iron Work. (Page 198.)

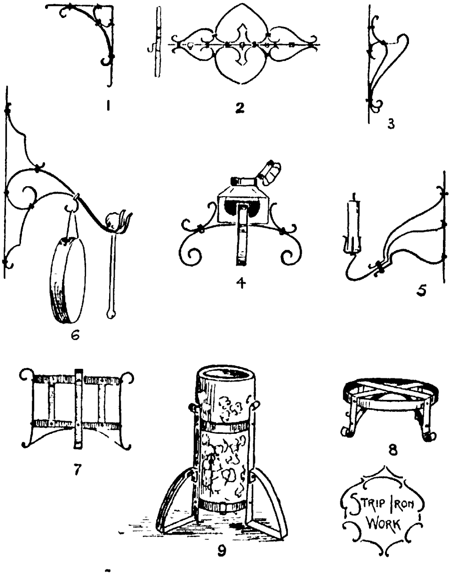
1. Bracket.
2. Key Rack.
3. Hat and Coat Hook.
4. Ink Stand.
5. Candle Bracket.
6. Gong Bracket.
7. Fern Pot Stand.
8. Ironing Stand.
9. Vase Stand.

Tin-Plate Work.

Cardboard modelling serves as an excellent introduction to tin-plate work, as the making of *nets* for boxes and trays in cardboard will help considerably in setting out the work in metal.

Tin-plate is the name given to thin sheets of mild steel, or wrought iron, which, after a cleaning process of pickling in acid and scouring, are dipped into vessels of molten tin having a layer of melted tallow floating on the top. The tallow acts as a flux and assists the liquid tin to adhere. The plates are then rolled to remove excess of tin and are dried in sawdust. They are procurable in different sizes and weights. For light work 30 S.W.G. should be used, and for heavy work 22 S.W.G.

Tools.—In tin-plate work a great many devices and machines are used for shaping the metal. In a manual training room these should not be found, or at least only those which are absolutely essential for the work.


1
2
3
6
4
5
7
9
8
Strip Iron Work

The following tools are recommended in addition to those already introduced for wire and bent iron work.

Boxwood Mallet, for straightening the sheets and for bending edges.

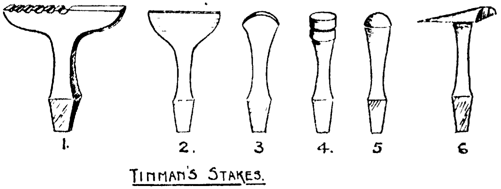


Fig. 469.

Stakes.—These are forms of anvils with square tapered shanks which fit in a hole in the bench. There are many different forms, but the following six will suffice for ordinary purposes. Most of the forms may be dispensed with by using suitably-shaped pieces of iron held in the vice. Fig. 469:—(1) Creasing stake. (2) Hatchet stake. (3) Half-moon stake. (4) Round stake. (5) Convex stake. (6) Funnel stake.

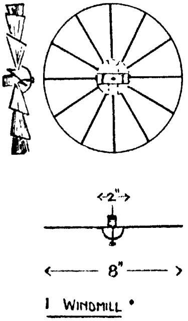


Fig. 470.

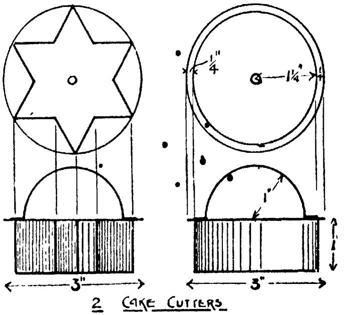
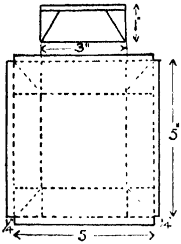


Fig. 471.



3. Box [Folded Corners]

Fig. 472.

Types of Tin-Plate Work.

1. Windmill (Fig. 470.)
2. Cake Cutters. (Fig. 471.)
3. Box with folded corners and edges. (Fig. 472.)
4. Box with lid, soldered corners. (Fig. 473.)
5. Sandwich Box with hinged lid. (Fig. 474.)
6. Nutmeg Grater (wired). (Fig. 475.)
7. Cake Tin, riveted ends, wired top. (Fig. 476.)

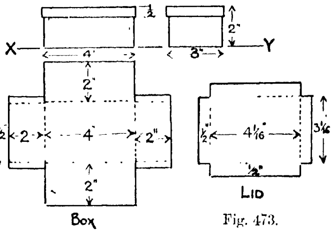
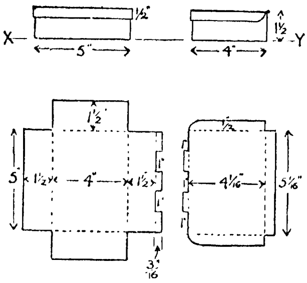


Fig. 473.

4 Box with Lid.

8. Sugar Scoop (Fig. 477)
9. Round Cake Tin, folded seam, wired top, loose bottom. (Fig. 478.)
10. Spirit Lamp. (Fig. 479.)
11. Funnel. (Fig. 480.)
12. Candle Lamp. Model utilising waste material; made from a tin canister. (Fig. 481.)



5. SANDWICH TIN Fig. 474.

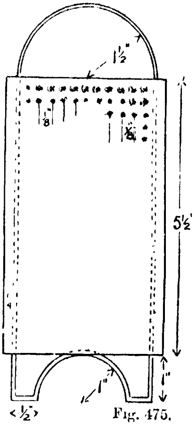
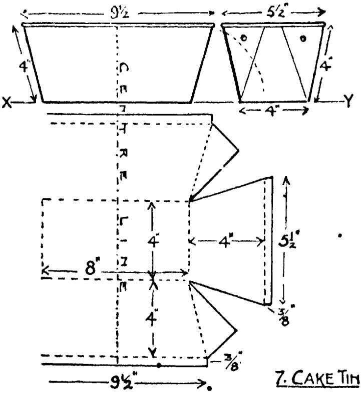


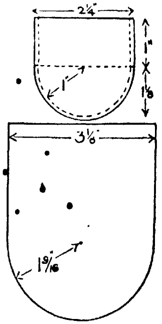
Fig. 475.

6 NUTMEG GRATER



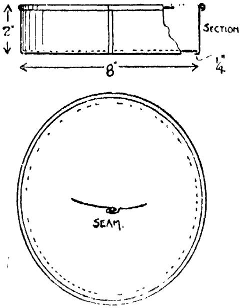
7. CAKE TIN

Fig. 476.



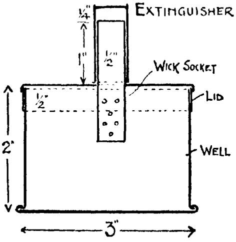
8. SUGAR SCOOP

Fig. 477.



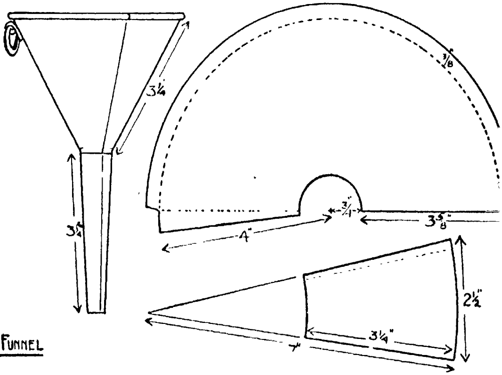
9. ROUND CAKE TIN [LOOSE BASE]

Fig 478.



10 SPIRIT LAMP [Sectional Elevatio

Fig. 479.



11 FUNNEL

Fig. 480.

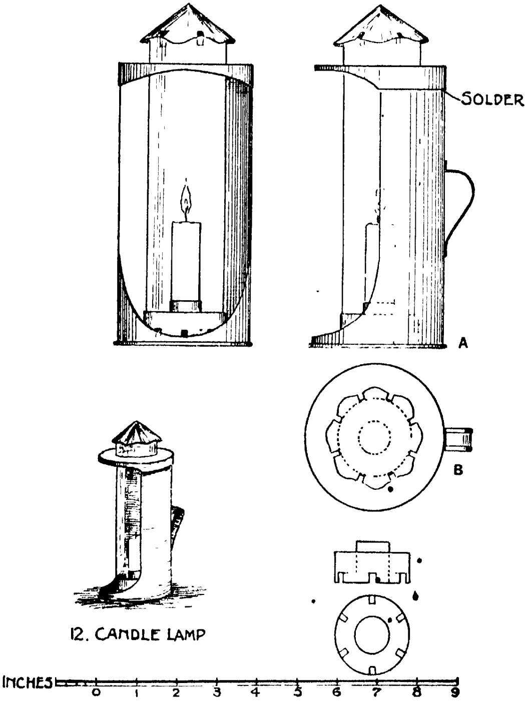


Fig. 481.

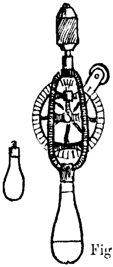


Fig. 482.

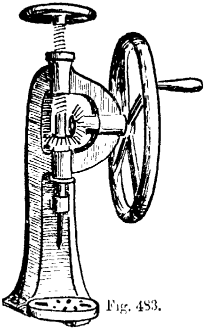


Fig. 483.

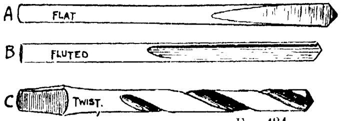


Fig. 484.

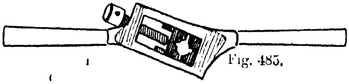


Fig. 485.

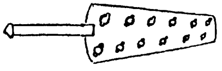


Fig. 486.

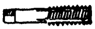
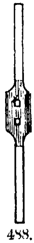


Fig. 487.



488.

Heavy Iron Work and Sheet-Metal Work.

This branch of metal work offers a very wide range of tool operations and models based on them. The materials used are hoop iron, wrought iron in bars and rods, heavy iron wire, sheet brass and sheet copper.

Additional Tools.—In addition to the tools already provided, the following will be required:—

Files of different cuts and sections, square, round, and three-cornered. Ward files for fine filing.

Cutting-out Tools.—Heavy shears for sheet iron, extra cross-cut chisels and hack saws.

Drilling Tools.—Drilling or boring holes in metal may be done on the lathe, on a drilling machine, or by means of a hand drill. The lathe is an expensive machine, and unless turning forms part of the course, either hand drills or a bench drilling machine should be installed. The hand drill (Fig. 482), is only suitable for light work, and take drills up to $\frac{3}{16}$ in. For heavier work a machine is necessary. Fig. 483 shows a handy form. Fig. 484, *a*, *b*, and *c*, shows flat, fluted, and twist drills respectively. The twist drill is the most expensive but is the most satisfactory in use. It clears its way as it works and makes a straight and parallel hole. To make a start for the drill a small conical hole is made with a centre punch.

Screw Cutting.—For cutting external threads, dies of various sizes and a stock to hold them are required. Fig. 485 shows the usual form. For small screws, most of the work can be done with a screw-plate (Fig. 486). For cutting internal threads, taps (Fig. 487) of various sizes will be needed. These are generally square at one end, and fit into holes in a special tap wrench (Fig. 488).

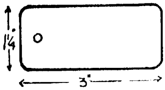
Types of Heavy Iron Work and Sheet-Plate Work.

Models 1 and 2. Plant Labels in sheet zinc. (Figs. 489 and 490.)

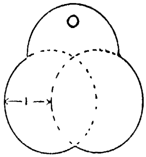
Model 3. Brass Escutcheon Plate. (Fig. 491.)

„ 4. Coat-hook, made in hoop iron and sheet iron. (Fig. 492.)

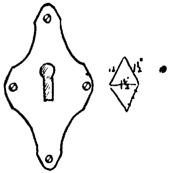
„ 5. Bracket, in hoop iron. (Fig. 493.)



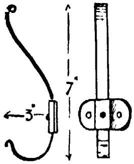
(1) PLANT LABEL
Fig. 489.



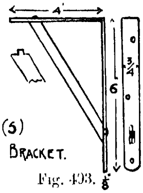
(2) PLANT LABEL
Fig. 490.



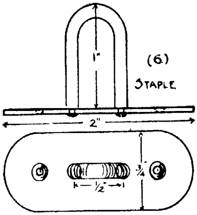
(3) ESCUTCHEON PLATE
Fig. 491.



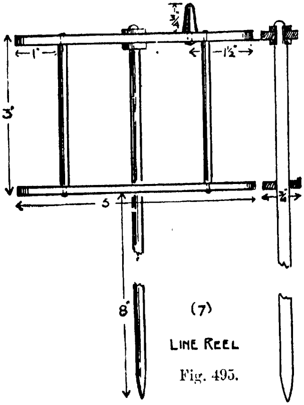
(4.) COAT HOOK
Fig. 492.



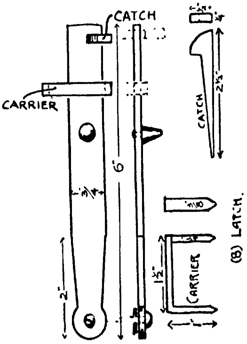
(5) BRACKET.
Fig. 493.



(6) STAPLE
Fig. 494.

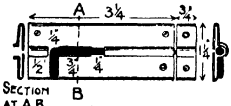


(7) LINE REEL
Fig. 495.

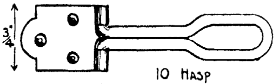


(8) LATCH.
Fig. 496.

Model 6. Staple, in hoop iron and heavy iron wire. (Fig. 494.)
" 7. Line Winder, in hoop iron and round wrought iron. (Fig. 495.)
" 8. Latch and fittings, in wrought iron. (Fig. 496.)
" 9. Bolt, in sheet iron and heavy iron wire. (Fig. 497.)
" 10. Hasp, in sheet brass and heavy brass wire. (Fig. 498.)
" 11. Hinge, in sheet copper. (Fig. 499.)
" 12. Letter Weight, in heavy sheet brass, or may be made from rough castings. (Fig. 500.)

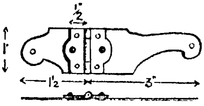


9 Bolt Fig. 497.



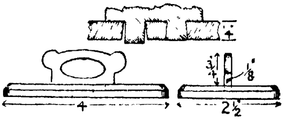
10 Hasp

Fig. 498.



11 Fancy Strap Hinge

Fig. 499.



12 Letter Weight

Fig. 500.

Model 13. Inside Callipers, sheet steel. (Fig. 501.)
" 14. Bevel, mild steel (screw provided). (Fig. 502.)
" 15. Tool-maker's Clamp, mild steel (blanks should be provided for the screw). (Fig. 503.)
" 16. Candle-stick, in sheet copper. The shaping is done by hammering with a ball-paned hammer on the end grain of a block of wood. (Fig. 504.)
" 17. Lamp for electric lamp, in sheet brass. (Fig. 505.)
" 18. Electric Lamp and bracket, in wrought iron and sheet copper. (Fig. 506.)

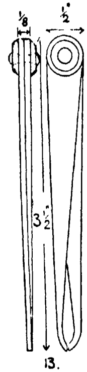


Fig. 501.

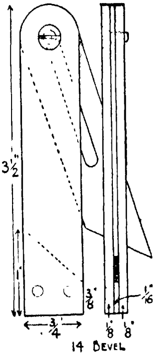


Fig. 502.

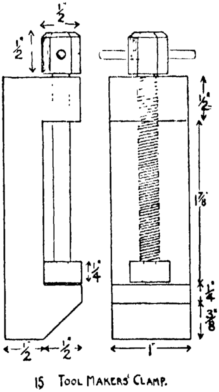


Fig. 503.

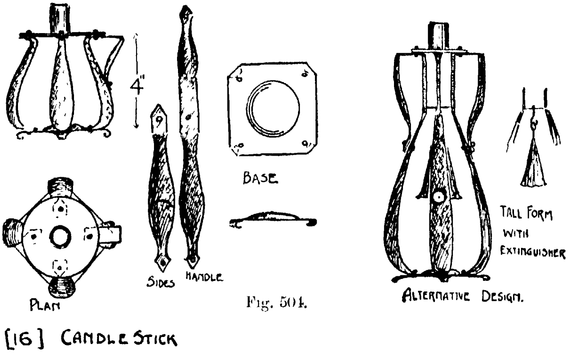


Fig. 504.

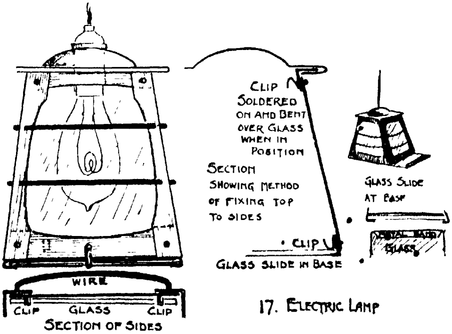
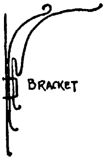
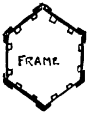
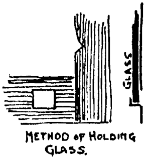
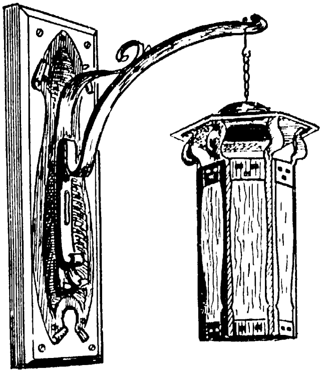


Fig. 505









18. LAMP & BRACKET for Electric Light.

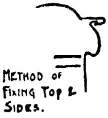


Fig. 506.

Repoussé Metal Work.

Repoussé metal work consists of raising designs on sheet metal by means of punches. It offers an excellent practical application of design as practised in the art room. The tools and apparatus required are few, and can mostly be made by the pupil himself.

Metal for Repoussé Work—Gold, silver, copper, brass, and wrought iron are all used in Repoussé work, but the most suitable for ordinary class work are copper and brass. Copper will be found most satisfactory, as brass is apt to be hard and brittle. Before commencing work the metal should be annealed to make it soft and ductile. This is done by heating it to a red heat and then plunging it into cold water. Repeated hammering hardens the copper, so that after a portion has been worked upon for a time, it becomes necessary to anneal it again to soften it. For the early exercises 26 gauge (I S W.G) should be used, and for those exercises where there is a considerable amount of relief 24 or 22 gauge.

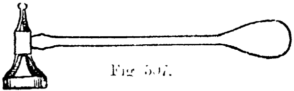


Fig 507.

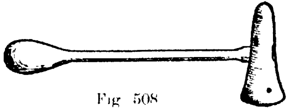


Fig 508

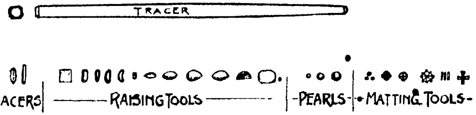


Fig. 509.

Tools required :—

Repoussé Hammer (Fig. 507.)—Small head, large face, ball pane ; very thin, springy, lance-wood shaft with ball handle.

Repoussé Mallet (Fig. 508).—Box-wood or lignum vitae head, lance-wood shaft.

Punches (Fig. 509).—These are made in a variety of shapes according to the work for which they are intended. The smaller tools are made of tempered steel and the larger ones of hard brass. *Tracers* are used for outlining the work. *Raising* tools are for raising the metal within the outline. *Pearls* are raising tools with circular points. *Matting Punches* are used for breaking up the background. Most of the punches, with the exception of some of the matting punches, can be made quite easily. $\frac{1}{8}$ in. and $\frac{3}{16}$ in. square and round bars of tool steel should be taken and pieces about 4 in long cut off. These should first be softened and then ground to shape on an emery wheel and finished off on emery cloth. They should then be tempered hard at the point and soft up to the top, and finished off to a high polish with emery powder and a buff wheel.

Piercing Saw (Fig. 510).—This is a variety of fret saw with stiff back, and saws specially made for cutting thin sheet metal. The work should be held on a cutting board, and the cut made with the down stroke.

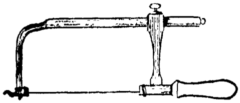


Fig. 510

Support for the Metal.—Various materials for supporting the metal are used. Wood blocks are sometimes used where the work is very simple and punching is done from one side only. The face of the wood becomes embossed, and needs to be planed flat for succeeding work Birch will be found to serve the purpose as the grain is even, close, and springy.

Lead Blocks.—Pieces of lead are melted and poured into a cast iron bowl. The lead is soft and yielding, but is cumbersome to handle; and requires to be melted down in order to get a flat surface.

"*Pitch*" *Blocks.*—A shallow tray is filled with a mixture of the following ingredients, all melted and thoroughly mixed together.

Soft Black Pitch	6 lb.
Russian Tallow	1 lb.
Resin	1 lb.
Plaster of Paris	6 lb.

The ingredients are added in the order given. The plaster of

Paris must be thoroughly dry and must be added slowly, stirring all the time.

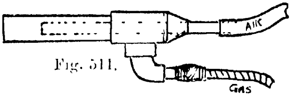


Fig. 511.

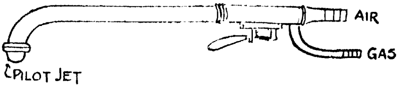


Fig 512

To soften the pitch when in use, some form of blow lamp is necessary. If gas is at hand, a form of mouth blowpipe (Fig. 511) will serve quite well. Fig 512 is a lever blowpipe used with a foot bellows. If gas is not at hand, a small spirit lamp and blowpipe (Fig. 513) could be used.

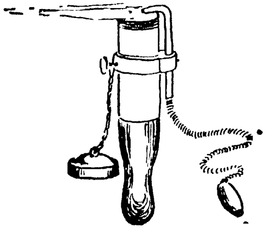


Fig. 513.

Sandbag.—This is a leather cushion, generally circular in shape, filled with fine sand. It is used in conjunction with the mallet for raising large portions of the metal such as bowls, trays, large leaves, and bosses.

In addition to the above special tools, the ordinary tools (shears, pincers, drills, etc.) of the metal workshop will be required for shaping the work when finished.

Exercises in Repoussé Work.

1. *Tray* (Fig. 514).—Simple exercise in tracing and matting. The metal is fixed to a board by means of tacks round the edge, the head of the tack over-lapping the metal The punching throws the rest of the pattern into relief. No raising is done from the back.

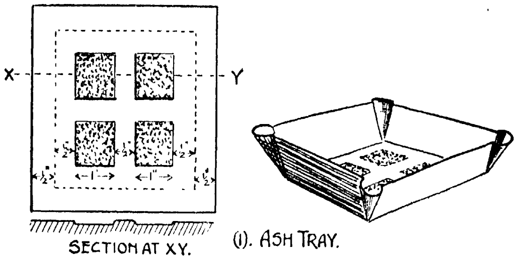


Fig. 514

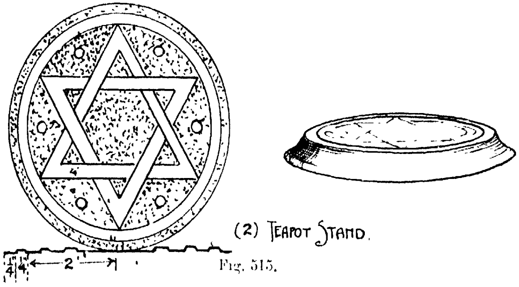


Fig. 515.

2. *Teapot Stand* (Fig. 515).—Exercise in tracing straight and curved lines, worked on a piece of birch board as in Model 1.

3. *Match Box* (Fig. 516).—Simple exercise in raising on the pitch block and cutting out with the piercing saw. The top is made separately and soldered to the sides when finished.

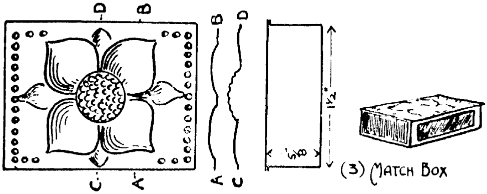


Fig. 516.

4. *Fancy Hinge* (Fig. 517).—More difficult exercise in raising and cutting out.

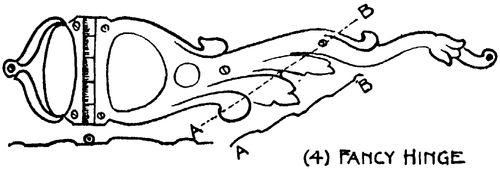


Fig. 517.

5. *Finger Plate* (Fig. 518).—The central portion is raised with a mallet on a sandbag, and afterwards is tooled on the front on the pitch block.

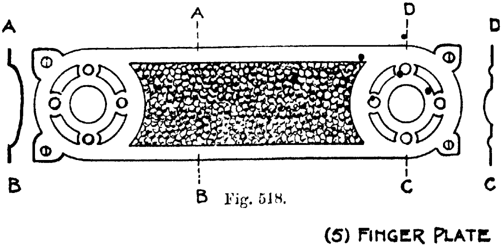


Fig. 518.

6. *Fruit Dish* (Fig. 519).—More difficult exercise in shaping with the mallet.

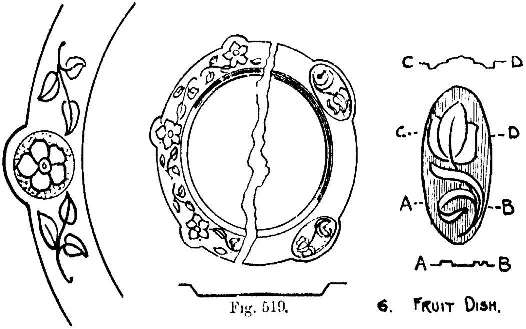


Fig. 519.

6. FRUIT DISH.

7. *Letter Box* (Fig. 520).—Exercise in lettering. The letters are raised from the back. The hinges for the lid are soldered in position on the back.

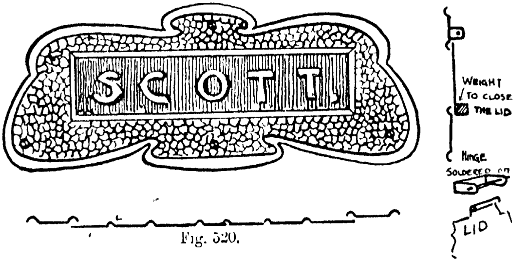


Fig. 520.

7. LETTER BOX.

8. *Crumb Tray* (Fig. 521).—Exercise in high relief. The leaves and grapes are first raised with the mallet and sandbag and finished off with suitable raising tools.

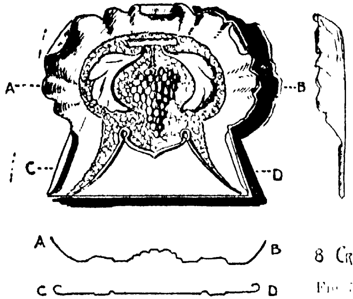


Fig. 521.

9. *Glove Box* (Fig. 522).—A model embodying most of the previous exercises

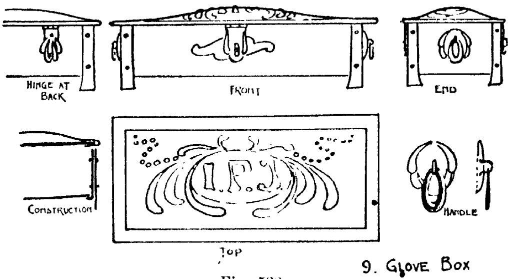


Fig. 522.

The front, ends, and back are made separately and are riveted to the corner pieces. The bottom piece rests on a flange on the sides. The top is fixed by hinges soldered to the top, inside, and riveted to the back. The front fastening is hinged and soldered inside the top. The handles on the ends hang in copper wire staples fixed as shown in sketch.

A cardboard box should be made to fit, and should be covered inside with plush or silk over-lapping the top edges. A flat piece should be made and fixed to the top so that it fits inside the cardboard box when the lid is closed.

Finishing the Work.—Copper repoussé work may be finished either bright or oxidized. To clean the copper and make it a bright red colour, heat the object slightly and dip it in a solution made up as follows:

Sulphuric Acid	1 part to 8 of water.
Nitric Acid	1 part to 6 of water.

After immersion it should be thoroughly rinsed in running water, dried and lacquered. A very good lacquer for small articles is Zapon. It is put on cold and is quick drying.

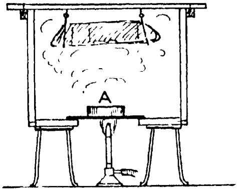


Fig. 523.

Oxidizing.—The object should first be thoroughly cleaned by pickling as above and dried. A box should be fitted up as shown in Fig. 523. The bottom has an iron plate which allows of the vessel *A* being gently heated with a bunsen burner. The article to be oxidised is suspended in the box, so that the fumes have free access to every part of it. In *A* is placed a small quantity of a weak solution of ammonium sulphite. The fumes are very disagreeable and the work should be carried on near an open window. When finished, the work should be rinsed in clean water and then dried. The high lights can be made bright with a soft rag and Crocus powder. When finished, the whole should be lacquered to preserve the appearance.

Forging.—For Manual Training there is no need to instal the full equipment of the blacksmith's shop. A forge, an anvil, two or three hammers and tongs and a few shaping tools will serve to give the pupils a knowledge of shaping and joining metal under the influence of heat.

The *Forge* (Fig. 524).—*A* is the hearth; *B* the water tank; *C* the bellows worked either by a hand lever or by a treadle; *D* the Tue-iron, the air duct to the hearth.

The *Fire Irons* for the Forge (Fig. 525).—(*A*) Poker, (*B*) Slice, (*C*) Rake.

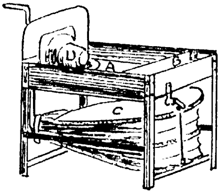


Fig. 524.

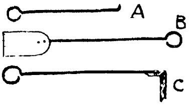


Fig. 525

The *Anvil* (Fig. 527).—(*A*) Face, slightly curved, steel faced; (*B*) Horn or Beak Iron; (*C*) Stand.

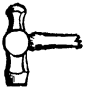


Fig 526.

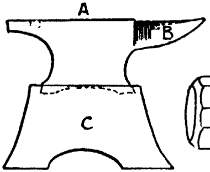


Fig. 527.

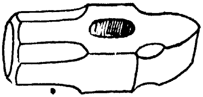


Fig. 528.

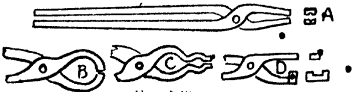


Fig. 529.

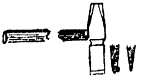


Fig. 531.

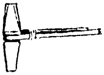


Fig. 530.

Fig. 532.

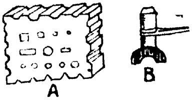


Fig. 533.

Tongs.—There are several forms of tongs employed in the blacksmith's shop, but the ones shown in Fig. 529 will be found most suitable. (*A*) Open-mouth Tongs; (*B*) Bolt Tongs; (*C*) Pick-up Tongs; (*D*) Side Tongs.

Hammers.—Hand Hammers (Fig. 526), about 2 lb. weight for light work. Sledge Hammer (Fig. 528), for heavy striking. For boys the weight should be about 7 lb.

Sets.—For cutting off pieces of iron. Hot Set (Fig. 530). Cold Set (Fig. 531). Hardie (Fig. 532), fits into a square hole in face of Anvil.

Shaping Tools.—The number of shaping tools introduced depends on the work to be undertaken. Fig. 533—(*A*) shows a Swage Block, and (*B*) a Top Swage. These are used for shaping cylindrical work after rough forging.

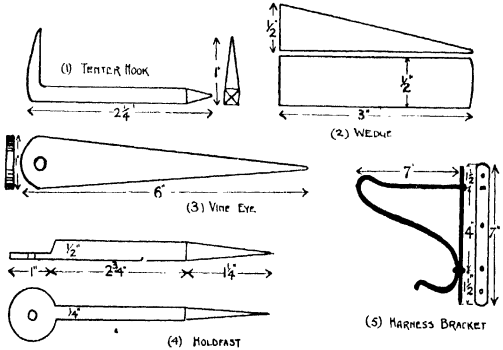


Fig. 534.—Exercises in Forging.

Types of Forging Exercises. (Fig. 534.)—

1. Tenter Hook.
2. Wedge.
3. Vine Eye.
4. Holdfast.
5. Harness Bracket.
6. Trace Hook.
7. Pan Handle.
8. Meat Hook.
9. Box Handle.
10. Garden Trowel.
11. Daisy Grubber.
12. Casement Latch.
13. Nail Punch.
14. Cold Chisel.
15. Drill.
16. Chain Links.
17. Chain Hook.
18. Tongs.

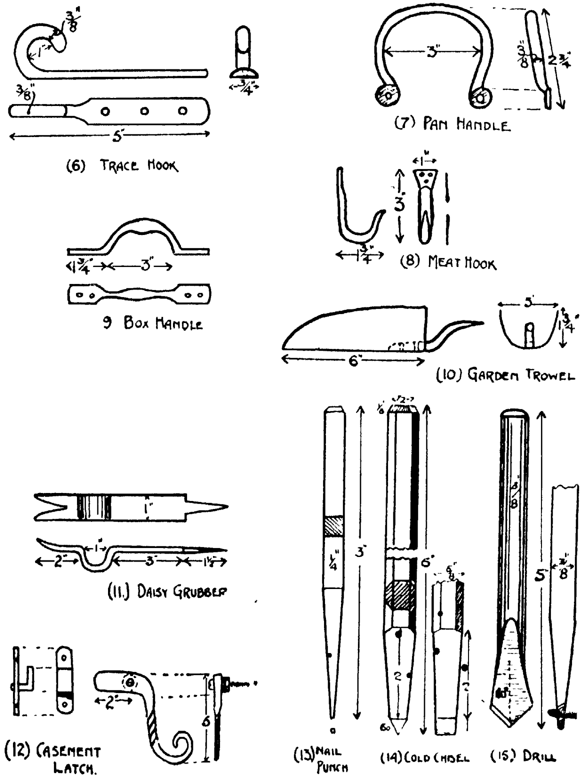


Fig. 534.—Exercises in Forging.

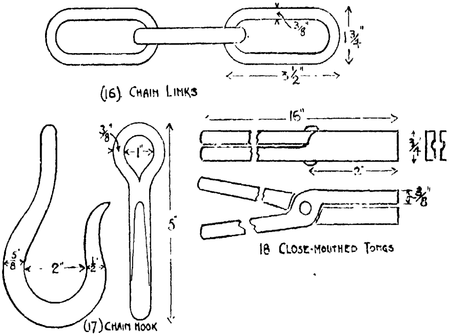


Fig. 534.—Exercises in Forging.

Turning and **Machine Work** necessitate expensive equipment, and for Manual Training purposes can be dispensed with, as they rightly belong to the Preparatory Trade School and the Technical School. In many cases the most important part of the work, viz. the setting of the machine, is done by the teacher, and the pupil merely watches the machine doing the work. This kind of work, too, demands almost individual tuition, or damage may be done both to the machine and to the pupil, and is only possible where the classes are very small or where the work of the class is so arranged that the teacher can devote most of his time to the boy at the machine. The work is heavy, and in most cases power, supplied by a motor or by a gas engine, is absolutely necessary.

INDEX.

Acer pseudo-platanus, 178
Age of children, selection of occupation, 7
Aims of Educational Handwork, 3
Alarm-clock bracket, (H. W.) 170, (S W.) 187
Alburnum, 118
Alphabet (P. W.), 51
American hammer, 155
  „ white pine, 121
Analytical method, 43
Angles of triangle, 95
Annealing copper, 211
Annual rings, 118
Anvil, 219
Area of circle (C. M), 95
  „ „ polygon (C. M), 95
  „ „ triangle (C M.), 95
Arkansas stones, 166
Artificial seasoning, 161
Ash leaves, 149
Ash, Lesson on, 174
Auger bit, 139
$(a + b)^2$ (C. M), 95
$(a + b)^3$ (C. M.), 95

Bag (R. W.), 29
Bag without seam (R W), 29
Baskets, coiled plaits (R. W.), 26
Basket-work, 32-42
Basswood, Lesson on, 144
Beech leaf, 149
Beech, Lesson on, 170
Bench hook, 102
Bench notes, 106
Bench stop, 102
Benches, Woodwork, 100
Bevel (H. I.), 208
Bevels, Grindstone and oilstone, 116
Binding edges (C M.), 68
Birch leaf, 149
Bird house (L W), 188
Bits, Lesson on, 138
Blotting pad (C M.), 81
Blow-pipes, 213
Boards, Modelling, 12
  „ , Slab, 12
Bolt (H I), 207
Book covers (R W), 31
  „ cradle (H. W.), 167
  „ marker (P. M.), 60
Bookbinding, 93
Bookstand (H. W), 176
Boring, Method of, 123
Bow saw, Lesson on, 141
Box, folded corners (T. P.), 200
  „ for clay modelling, 14
  „ handle (F), 221
  „ , hinged lid (T P), 200
  „ , Rectangular, with lid (C. M.), 61
  „ , Square, (C. M.) 64, (R. W.) 23
  „ with lid (C. M.), 78
Brace, Lesson on, 124
Bracket, (H. I.) 206, (S. I.) 198
  „ , Alarm-clock (H. W.), 170
Bradawl, Lesson on, 143
Brads, Cut, 153
  „ , Oval, 153

Cabin hook (W. W.), 194
Cake cutters (T. P.), 199
  „ tin (T. P.), 201
  „ tin round (T. P.), 202
Calendar (C. M.), 76
  „ stand (L. W.), 187

Callipers, inside (H. I.), 208
Cambium, 118
Canary wood, pine, 114
Candle bracket (S. I.), 198
  „ lamp (T. P.), 203
  „ shade (C. M.), 73
Candlestick (H. W.), 134
Candlesticks (S. M.), 209
Cane basket weaving, 35
  „ weaving, Notes on, 9
Cap iron, 136
Carborundum stones, 166
Cardboard modelling, general method, 43
Cardboard work, Notes on, 9
Carving, Notes on, 9
Casement latch (F.), 221
Casting frame, 17
  „ in plaster of Paris, 16
Centre cane, 35
  „ of gravity (C. M.), 95
Centre-bit, Lesson on, 124, 138
Centres, 5, 8
Chain hook (F.), 222
  „ links (F.), 222
Chains (W. W.), 194
Chair (L. W.), 189
Change of motion (C. M.), 99
Characteristics of British timber trees, 146
Charnley Forest stone, 166
Chisel handles, 116
  „ , Lesson on, 115
Clasp nails, 152
Clay, its advantages, 11
  „ modelling, general method, 14
  „ „ , suitable models, 15
  „ storage and preparation, 13
Clogging of files, 127
Close-mouthed tongs (F.), 222
Clothes hanger (H. W.), 139
Coat hook (H. I.), 206
Coiled basket work, 32
Cold chisel, 193, (F.) 221
Comb case (C. M.), 62
Compass card (C. M.), 63
Compound leaves, tearing exercises, 50
Continuity, 3
Contour models in clay, 16
Correlation, 4, 93
Cortex, 118
Couch (L. W.), 189
Countersink bits, 139
Crayon box (C. M.), 68
Crib (L. W.), 189
Cross-section of a tree, Lesson on, 118
Crumb tray (C. R.), 217
Cube (C. M.), 66
Cubic decimetre (C. M.), 95
Cupboards, 104
Cup shake, 164
Curriculum, inclusion of Handwork, 1
Curtain band (R. W.), 31
Cutting iron, 136
  „ slabs, 48

Daisy grubber, 221
Dammar, 130
Dammara Australis, 130
Defects in timber, Lesson on, 164
Design—paper tearing, 51
Dibble (H. W.), 161
Dog kennel (C. M.), 71
Doll's swing (L. W.), 184
Double hanging pocket (P. W.), 55
Dovetail, Common, 172
  „ , Lap, 176
Draining stand (L. W.), 184
Draught-board, Folding (C. M.), 83
Draughtsman's scale (C. M.), 95
Drawing—cardboard modelling, 44
  „ woodwork, 105
Drills, 205, 221
Duramen, 118

Eccentric motion (C. M.), 99
Edge joint, Glued, 157
Educational Handwork, its meaning, 1
Egg lifter (W. W.), 194
Egg switch (W. W.), 194
Electric lamp (S. M.), 209
Elm leaf, 149
Elm, Lesson on, 173

Engine (T. M.), 189
Envelope, Photo (P. W.), 59
„ Specimen (P. W.), 59
Equipment, 8
Escutcheon plate (S. M.), 206
Exeter hammer, 154

Face side, 110
Fagus Sylvatica, 170
Feeding trough (L. W.), 187
Felling, 159
Fern basket (L. W.), 188
„ pot stand (S. I.), 198
Figure 8 stitch, 33
Files for metal work, 193
„ , Lesson on, 126
Finger plate (C. R.), 215
Fir leaves, 148
Fire-irons, Blacksmith's, 219
Fixing, Method of (C. M.), 48
Flux, soldering, 194
Flying wheel (T. M.), 189
Folding draught-board (C. M.), 83
„ towel rail (H. W.), 165
Forge, 219
Forging, 218
Frame for lamp shade, 194
Fraxinus Excelsior, 175
French nails, 153
Fretwork, Notes on, 9
Froebel, 2
Fruit dish (C. R.), 216
Funnel, (T. P.) 202, (P. W.) 53

Gall nuts, 169
Garden dibble, (H. W.) 161, (L. W.) 188
„ seat (L. W.), 184
„ trowel (F.), 221
Gate (L. W.), 184
Geometrical drawing, cardboard modelling, 44, 45
Glass paper, 127
Glove box (C. R.), 217
Glue, Lesson on, 156
Gong bracket (S. I.), 198
Gouge bit, 139
„ , Lesson on, 143
Grain of the wood, Lesson on, 111
Grounding punch, 146
Gullet, 128

Hack saw, 193
Hair tidy, (C. M.) 66, (R. W.) 25
Half-cut, 18
Hammer, Method of using, 155
„ , Repousse, 211
Hammers, Blacksmith's, 220
„ , Lesson on, 154
Handkerchief box (H. W.), 169
Handles for baskets, 34
Hanging pocket (C. M.), 72
Harness bracket (F.), 220
Hasp (H. I.), 207
Hat and coat hook (S. I.), 198
Hat peg (H. W.), 163
Heart shake, 164
Heavy iron work, 205
Hexagonal spill holder, 80
„ tray (C. M.), 75, 90
Hinge, Fancy strap (H. I.), 207
„ , Repoussé (C. R.), 215
Hoe (L. W.), 188
Holdfast (F.), 220
Hook, Bench, 102
Hurdle (L. W.), 189
Hygroscope (C. M.), 99

Incannelled gouge, 144
Inclination and ability of teacher, 7
Industrial schools, 3
Inkstand, (H. W.) 142, (S. I.) 198
Instruction, Individual, 105
Intersection of planes, 95
Ironing stand (S. I.), 198
Irons of plane, 133, 136

Jack plane, Lesson on, 113, 132
„ „ , Setting, 115
Jaws of brace, 125
Jotter case (C. M.), 82
Juglans regia, 179

Kauri pine, Lesson on, 130
Kerf, 114
Key label, (H. W.) 108, (L. W.) 187
„ rack, (L. W.) 187, (S. I.) 198

Knife strop (L. W.), 187
Knives for cardboard modelling, 47

Ladder (L. W), 183
Lamp and bracket (S. M), 210
,, , Electric (S M.), 209
,, shade frame (W. W), 194
Larch leaf, 148
Latch (H I), 206
Lazy squaw stitch (R W), 34
Leaf, Lesson on, 151
,, tearing, 49
Leaves, Shapes of, 148, 149
Letter-box (C. R), 216
,, holder (H. W.), 146
,, portfolio (C. M), 86
,, stand (L W), 187
,, weight (H. I), 207
Letterette (P. W), 58
Light woodwork, 181
Lighting of workshop, 100
Lime leaf, 149
Line reel (H. I), 206
Lines used in drawing, 109
Litre (C. M), 95
Locality and form of handwork selected, 7
Loom for raffia weaving, 28, 29, 30
Luggage label (P W.), 61

Machine work, 222
Mallet, Repoussé, 211
Mandrels, 194
Manilla paper, 46
Marble board (L. W), 187
Marking gauge, Lesson on, 119
Marquetry work, Notes on, 9
Mast, 170
Mat (P. W.), 54
,, , cane weaving, 37
,, , circular, (C. M.) 71, (R. W) 21
,, , ,, , with centre (R W.), 21
,, , coiled plait, 26
,, , continuous woof, 29
Mat-weaving, 28
Match-box (C. R), 215
,, holder (L. W.), 187
Match holder (C. M.) 78, (H. W.) 123
,, stand (C. M.), 67
Material for light woodwork, 181, 184
Material for wire work, 192
Materials, Cardboard modelling, 46, 52, 60, 75
Materials for heavy iron-work, 205
Materials, Plastic work, 11
Matting tools, 212
Meat hook, (F.) 221, (W. W.) 195
Media, 6
Medulla, 118
Medullary Rays, 118
Mentally defective children, 2
Metal for repoussé work, 211
Metal-work, 191
,, , Notes on, 10
Method, General paperwork and cardboard modelling, 13
Method, General plastic work, 15
,, ,, woodwork, 104
Metric rule (C. M), 93
Milking stool (L W.), 188
Moments, Model to illustrate (C. M), 95
Money box (C. M), 76
Mortise, closed, 164
,, , open, 162
Motion, Change of (C. M.), 99
Mount (C. M.), 75

Nail box (H. W.), 151
,, punch, 154, (F.) 221
Nails and nailing, Lesson on, 152
Natural seasoning, 160
Needle case (R. W.), 23
Newspaper rack (H. W.), 178
Northern Pine leaf, 148
,, ,, , Lesson on, 124
Nose bit, 139
Note-book, 62
Notes, Bench, 106
Nutmeg grater (T. P.), 201

Oak leaf, 149
,, , Lesson on, 168
Octagonal mat (C. M.), 75
Oil for oilstones, 167
Oilstone slip, 143, 167
Oilstones, Lesson on, 166
Oxidising copper, 218

Paintbrush case (C. M.), 87
Pan handle (F.), 221
Paper folding, Notes on, 9
  ,, knife (H. W.), 159
  ,, knives (L. W.), 187
  ,, work, 49
Paring chisel, 116
Pattern weaving, 30
Pearls, 212
Pencil case (C. M.), 79
Pentagonal lamp shade (C. M. 73
Peruvian coil, 34
Pestalozzi, 2
Photo easel (L. W.), 184
  ,, envelope (P. W.), 59
  ,, frame, (C. M.) 88, (L. W.) 184, (R. W.) 21
Pickling bath, 218
Picture frame, Passé-partout (C. M.), 88
Piercing saw, 212
Pima coil, 33
Pincers, Lesson on, 153
Pincushion (L. W.), 188
Pin joint (H. W.), 169
  ,, tray (H. W.), 144
Pine gum, 48
  ,, leaves, 148
Pinus strobus, 121
  ,, sylvestris, 124
Pipe rack (W. W.), 194
Pitch block, 212
  ,, of teeth, 127
Plaiting, Raffia, 25
Plane irons, Lesson on, 136
Plant label, (H. W.) 115, (L. W.) 187, (S. M.) 206
Plastic work, Notes on, 8
Plasticine, 8, 11
Pliers, 192
Pocket wallet, (C. M.) 83, (P. W.) 62
Pointer (H. W.), 129
Poplar leaf, 149
Portfolio, (C. M.) 86, (P. W.) 60
Position, Correct working, 106
Pot stand (L. W.), 184
  ,, stick (L. W.), 187
Preparatory Technical Schools, 2
Pricker, 47
Prismatic stand (C. M.), 71
Projections of a line (C. M.), 95
Psychological aspect of Educational Handwork, 2
Pulley (C. M.), 95
Pump (C. M., 69
Punch for riveting, 196
Punches, Repousse, 212
Pyramids, Congruent (C. M., 95

Quercus robur pedunculata, 168
  ,, ,, sessiliflora, 169

Racks for tools woodwork, 100
Raffia work, 19
  ,, ,, Notes on, 8
Railway signal (L. W.), 184
Raising tools, 212
Rake (L. W.), 188
Rasp 127
Reamer 139
Records, 106
Rectangular box, with lid, 64
Red Pine, Lesson on, 124
Redwood, Lesson on, 123
Reel-holder (H. W.), 117
Repoussé metal work, 211
Ring (W. W.), 194
Rivet set, 196
Riveting 196
  ,, hammer, 154
Rivets, 196
Rope border, basket work, 41
Round ruler (H. W.), 125
Rousseau, 2
Rule, Lesson on, 111
Ruler (L. W.) 183
Rustic woodwork, 187

Sandbag, 213
Sandpaper block (H. W.), 108
Sandwich box (T. P.), 201
Saw set, 128
Scale (C. M.), 95
Scheme of woodwork exercises, 107
Scissors, 46
Scoop, 189
Scotch Fir, 124
Screw cutting, 205

Screw plate, 205
Screwdriver bit, 139
„ , Lesson on, 133
Screws, Lesson on, 133
Scroll plate, 197
Seasoning, 160
Section of a cube (C. M), 95
Seed label (H. W.), 119
Selection of models (C. M), 44
„ „ occupation, 6
Serviette ring (C. M), 87
„ „ (L. W), 188
„ „ (R. W.), 24
Set of teeth, 128
Sets, Blacksmith's, 220
Setting a jack plane, 115
Shaping tools, Blacksmith's, 220
Sharpening gouges, 144
Sheet-metal work, 205
Shell bit, 139
Shrinkage, 162
Sign post (L. W), 184
Silk winder (C. M), 63
Silver grain, 119
„ „ of oak, 168
Simple coil, 32
Skewer (W. W), 194
Slab board, 13
Slipstone, 144
Sloyd knife, 181
„ „ work, 184
Smoothing plane, Lesson on, 132
Snake 189
Snips, 196
Solder, 194
Soldering apparatus, 193
Spangles on oak leaf, 169
Specialist 4
Specimen envelope (P W.), 59
„ models, 106
Spill holder (C. M.), 80
Spiral puzzle (W. W.), 194
Spirit lamp (T. P), 202
Split cane, 42
Spokeshave, Lesson on, 140
Spoon bit, 139
Square box (C. M.), 64
„ decimetre (C. M.), 95
„ prism, 68
Square tray (C. M.), 76
„ tray, sloping sides (C. M.), 65
Stakes, Tinman's, 199
Staple (H. I.), 206
Star shake, 164
Stocks and dies, 205
Straight edges (C. M.), 48
String winder (L W), 187
Strip iron work, 195
„ woodwork, 181
Sugar scoop (T. P.), 201
Supplementary models (C M.), 93
Swage block, 220
S. W G , 192
Sycamore leaf, 149
„ , Lesson on, 178

Table (L. W.), 189
„ centre (R W.), 31
„ mat, Inlaid (H W), 157
Tap wrench, 205
Taper holder (C. M), 72
„ „ (R. W.), 31
Taps, 205
Tea tray (H. W.), 173
Teacher of handwork, 4
Teapot stand (C. R.), 214
Tearing, 53
Technical point of view, 5
„ training, 2
Tee square (H. W.), 155
Teeth of saws, Lesson on, 127
Teetotum (L. W.), 187
Template, Right angle (P. W.), 61
Tenon saw, Lesson on, 114
Tenter hook, 220
Test-tube stand (H. W.), 150
Theodolite (C. M), 95
Tilia Americana, 144
Tinman's stakes, 199
Tin-plate, 197
„ „ work, 197
Tinted boards, 46
Toasting fork (W. W.), 194
Tongs, Blacksmith's, 220
Tool rack (H. W), 130
„ racks, 100
Toolmaker's clamp (H. I), 208

Tools for cardboard modelling, 46, 52, 60, 75
„ „ clay modelling, 12
„ , Woodwork, cost, 102
Toothbrush rack (H. W.), 137
„ „ „ (L. W.), 184
Towel rail, folding (H. W.), 165
Toy making 189
Tracers, 212
Trade schools, 2
Tray (L. W.), 187
„ , Ash (C. R.), 214
„ , Pen (C. M.), 65
„ , Square (P. W.), 57
„ , Square, sloping sides (C. M.), 65
„ with flaps (P. W.), 57
Trees, General characteristics, 146
Triangle, angles (C. M.), 95
„ area (C. M.), 95
„ squares on sides (C. M.), 95
Triangular bag (P. W.), 55
Trinket box (C. M.), 91
Try square, Lesson on, 111
„ „ (L. W.), 187
Trying plane, Lesson on, 132
Turkey stones, 166
Turn buttons (H. W.), 113
Turning, 222
Twist bit, 139

Ulmus campestris, 173
„ montana, 173
Utilitarian point of view, 2

Vase stand (S. I.), 198
Vice, 192
„ clamps, 192
Vine eye (F.), 220
Vocational schools, 2
Vortex ring box (C. M.), 99

Wall pocket (P. W.), 54
Wallet (R. W.), 31
Walnut leaf, 149
„ , Lesson on, 179
Waney edges, 164
Warrington hammer, 154
Washita stones, 166
Watch stand (L. W.), 187
Water pocket (P. W.), 52
Water-wheel (C. M.), 99
Wax inlaying, 168
Weaving, 27
„ patterns, 30
Wedge, 137
Wedge (F.), 220
Weymouth Pine, 121
Wheel-barrow (L. W.), 189
Whirligig, 189
Whistle (L. W.), 188
Windmill, (L. W.) 189, (P. W.) 56, (T. P.) 199
Wire staple, 194
Wire work, 192
Wood store, 104
Woodwork, light, Notes on, 9
„ , Notes on, 9
Workshop, 100
Writing case (C. M.), 84
Wrought nails, 152

Yellow Fir, Lesson on, 124
Yellow Pine, Lesson on, 119

DIRECTOR OF INDUSTRIES
Bengal

PRINTED AT THE BURLINGTON PRESS, CAMBRIDGE.

A complete Catalogue of Text-Books published by the University Tutorial Press, and separate Sectional Catalogues in English Language and Literature, French, Mathematics, and Science, may be had on application to the Publisher.

SELECTED TEXT-BOOKS

IN

PHILOSOPHY, EDUCATION, ART AND MUSIC

PUBLISHED BY THE

University Tutorial Press Ld.,
HIGH ST., NEW OXFORD ST., W.C.

Philosophy.

Ethics, A Manual of. By J. S. MACKENZIE, Litt.D., M.A., Professor of Logic and Philosophy in the University College of South Wales and Monmouthshire, formerly Fellow of Trinity College, Cambridge, Examiner in the Universities of Cambridge and Aberdeen. *Fourth Edition, Enlarged.* **6s. 6d.**

Logic, A Manual of. By J. WELTON, M.A., D.Lit., Professor of Education in the University of Leeds. 2 vols.

Volume I. *Second Edition.* **8s. 6d.**

Volume II. **6s. 6d.**

Vol. I. contains the whole of Deductive Logic, except Fallacies, which are treated, with Inductive Fallacies, in Vol. II.

Logic, Intermediate. By JAMES WELTON, M.A., D.Lit., Professor of Education in the University of Leeds, and A. J. MONAHAN, M A. With Questions and Exercises. **7s. 6d.**

This book is based upon the *Manual of Logic*; it is a simpler and briefer treatment adapted to the Intermediate University examinations.

Philosophy—*continued.*

Logic, Exercises in. By F. C. BARTLETT, M.A. **2s. 6d.**

Logic, Questions on, with Illustrative Examples. By H. HOLMAN, M.A., H.M.I., and M. C. W. IRVINE, M.A. **2s. 6d.**

Psychology, A Manual of. By G. F. STOUT, M.A., LL.D. *Third Edition, Revised and Enlarged.* **8s. 6d.**

Psychology, The Groundwork of. By G. F. STOUT, M.A., LL.D., Fellow of the British Academy. **4s. 6d.**

The work is not an abridgment of the *Manual of Psychology.* Even where the matter presented is substantially the same, the mode of presentation is different.

Education.

Principles and Methods of Teaching. By JAMES WELTON, D.Lit., M.A., Professor of Education in the University of Leeds. *Second Edition, Revised and Enlarged.* **5s. 6d.**

The Teaching of Modern Subjects (from *Principles and Methods of Teaching*).

(1) THE TEACHING OF ENGLISH (Reading, Language, and Literature). **1s.** (2) THE TEACHING OF GEOGRAPHY **1s** (3) THE TEACHING OF HISTORY. **1s.** (4) THE TEACHING OF MATHEMATICS AND SCIENCE. **1s. 6d.** (5) THE TEACHING OF MUSIC. **6d.** (6) THE TEACHING OF FOREIGN LANGUAGES. **1s.**

Principles and Methods of Moral Training with Special Reference to School Discipline. By Professor JAMES WELTON, D.Lit., M.A., and F. G. BLANDFORD, M.A., Lecturer in Education in the Cambridge University Training College. **3s. 6d.**

Principles and Methods of Physical Education and Hygiene. By W. P. WELPTON, B.Sc., Master of Method in the University of Leeds. With a Sketch of the History of Physical Education by Professor JAMES WELTON, D.Lit., M.A. **4s. 6d.**

This book is also issued without the chapters on Hygiene, under the title *Physical Education.* **3s. 6d.**

Education—*continued.*

Experimental Psychology in Relation to Education, An Introduction to. By C. W. VALENTINE, M.A., D.Phil., St. And. Lecturer in Experimental Psychology to the St. Andrews Provincial Committee for the training of Teachers, and Assistant in Education in the University of St. Andrews. **2s. 6d.**

Psychology, Fundamentals of. A brief account of the Nature and Development of Mental Processes for Teachers. By B. DUMVILLE, M.A., F.C.P. **4s. 6d.**

Child Mind. An Introduction to Psychology for Teachers. By BENJAMIN DUMVILLE, M.A., F.C.P. **2s. 6d.**

Text-Book of Hygiene for Teachers. By R. A. LYSTER, M.D., B.Sc., D.P.H., Medical Officer of Health for Hampshire, and Chief Medical Officer to the Education Committee. **4s. 6d.**

School Hygiene. By R. A. LYSTER, M.D., B.Sc., D.P.H. *Second Edition.* **3s. 6d.**

School Organisation. By S. E. BRAY, M.A., Inspector of Schools to the London County Council. With a Chapter on "The Place of the Elementary School in a National System of Education," by Sir J. H. YOXALL. *Second Edition.* **3s.**

School Training. By R. E. HUGHES, M.A. **2s.**

The Life and Work of Pestalozzi. By J. A. GREEN, M.A., Professor of Education in the University of Sheffield. **4s. 6d.**

The Educational Ideas of Pestalozzi. By J. A. GREEN, M.A. **2s. 6d.**

The Educational Ideas of Froebel. By J. WHITE, D.Sc. **1s.**

Synthesis of Froebel and Herbart. By R. D. CHALKE, M.A., LL.D. **3s. 6d.**

The chief aim of the book is to trace the relation of Pestalozzi, Froebel, and Herbart to each other and to the progress of modern education.

The Edgeworths. A Study of Later Eighteenth-Century Education. By A. PATERSON, M.A. Edin., Ph.D. Jara. **1s. 6d.**

Education—*continued.*

History of Elementary Education in England and Wales, from 1800. By C. Birchenough, M.A., Lecturer in Education and Master of Method at Sheffield University. **4s. 6d.**

Nature Study, the Aims and Methods of. A Guide for Teachers. By John Rennie, D.Sc., F.R.S.E. With an Introduction by Professor J. Arthur Thomson. **3s. 6d.**

The greater part of the book is devoted to model courses and model lessons dealing with typical studies and designed for all grades in the school. All branches of nature study are included.

Nature Study, the Aims and Methods of (South African Edition). By John Rennie, D.Sc., F.R.S.E., and George Rattray, M.A., D.Sc. **3s. 6d.**

School Lessons in Plant and Animal Life. By John Rennie, D.Sc., F.R.S.E. **4s. 6d.**

A course of eighty lessons in Nature Study, with full guidance to the teacher as to how to learn and how to teach the subject.

School Gardening, with a Guide to Horticulture. By A. Hosking, Lecturer in Horticulture and Chief Supervisor of School Gardens, West of Scotland Agricultural College. With numerous illustrations and plans. **2s. 6d.**

The Teaching of Drawing: its Aims and Methods. By S. Polak and H. C. Quilter. **2s. 6d.**

The scheme of the work falls under three heads as follows:—(1) the aims to be kept in view in the teaching of Drawing, (2) the methods by which a teacher should try to realise these aims, and (3) the use of Drawing to illustrate lessons on drawing and on other subjects.

The Teaching of Needlework: its Aims and Methods. By Miss H. M. Bradley, B.A. **1s. 6d.**

Voice Training in Speech and Song. By H. H. Hulbert, M.A., M.R.C.S., L.R.C.P. **1s. 6d.**

The Science of Speech: an Elementary Manual of Phonetics for Teachers. By B. Dumville, M.A., F.C.P. **2s. 6d.**

Manual Training. By A. H. Jenkins.

DIRECTOR OF DUSTRIES.
Ben al